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Charles Roome

THE

AMERICAN GAS LIGHT ASSOCIATION.

REPORT OF PROCEEDINGS

OF THE

Seventeenth Annual Meeting, Held at Baltimore,

OCTOBER 16, 1889,

THE

Eighteenth Annual Meeting, Held at Savannah,

OCTOBER 15, 1890,

AND THE

Nineteenth Annual Meeting, Held at New York,

OCTOBER 21, 1891.

SEPTEMBER, 1892.

PUBLISHED BY ORDER OF THE ASSOCIATION.

A. B. SLATER, JR., SECRETARY.

PRESS OF E. L. FREEMAN & SON PROVIDENCE R I

BOUND VOLUMES OF PROCEEDINGS.

Many of our present members joined the Association after its organization and therefore have not obtained complete sets of the proceedings. The Association has in stock a number of the several volumes and the Secretary can furnish them to members as follows:

General Index, Vol's 1 to 8 incl.,		Paper Covers	....	\$0.25
Volume 1, 1873-74,		" "	....	1.00
"	2, 1875-76,	Cloth "	....	1.50
"	3, 1877-78,	" "	....	1.50
"	4, 1879-80,	" "	....	1.50
"	5, 1881-82,	" "	....	1.50
"	6, 1883-84,	" "	....	1.50
"	7, 1885-86,	" "	....	1.50
"	8, 1887-88,	" "	....	1.50
"	9, 1889-90-91,	" "		

ALPHEUS B. SLATER, JR.,

Secretary.

PROVIDENCE, R. I.

The American Gas Light Association is indebted to the courtesy of the AMERICAN GAS LIGHT JOURNAL and also LIGHT, HEAT AND POWER for nearly all of the cuts used in illustrating the papers of the various authors.

A. B. SLATER, JR., *Secretary.*

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A. D. Slater.

SEVENTEENTH ANNUAL MEETING

OF THE

AMERICAN GAS LIGHT ASSOCIATION,

HELD AT

CONCORDIA HALL, BALTIMORE, MD.,

OCTOBER 16 AND 17, 1889.

FIRST DAY, MORNING SESSION—WEDNESDAY, OCTOBER 16.

The Convention was called to order at 10:30 A. M., by the President, Mr. A. B. Slater, of Providence, R. I.

The Secretary, Mr. C. J. R. Humphreys, being absent on account of sickness, Mr. William Henry White was elected Secretary *pro tem.*

On motion of Mr. Harbison, the reading of the minutes of the last annual meeting was dispensed with, the same having been published in the gas journals.

ROLL CALL.

The following members were in attendance:

Honorary Member.

Prof. E. G. Love, Ph. D., New York, N. Y.

Active Members.

Adams, H. C.,	Philadelphia, Pa.
Adams, Wm. C.,	Richmond, Va.
Addicks, J. Edward,	Philadelphia, Pa.
Africa, J. Simpson,	Huntington, Pa.
Allen, Augustus L.,	Poughkeepsie, N. Y.
Amory, Dr. Robt.,	Brookline, Mass.
Andrew, Jno.,	Chelsea, Mass.

Atwood, H. A., - -	Plymouth, Mass.
Bartlett, E. L., - -	Baltimore, Md.
Baumgardner, John H., -	Lancaster, Pa.
Baxter, Isaac C., - -	Detroit, Mich.
Baxter, Robert, - -	Halifax, Nova Scotia
Baxter, Wm. H., - -	Petersburg, Va.
Betts, Edward, - -	Wilmington, Del.
Bierce, Frank, - -	Memphis, Tenn.
Bill, George D., - -	Malden, Mass.
Blodget, Chas. W., - -	Brooklyn, E. D., N. Y.
Boardman, A. E., - -	Macon, Ga.
Boardman, Henry, - -	Bangor, Me.
Borgner, Cyrus, - -	Philadelphia, Pa.
Bredel, Frederick, - -	New York, N. Y.
Brown, E. C., - - -	New York, N. Y.
Bush, Jno. S., - -	New York, N. Y.
Byrne, Thos. E., - -	Brooklyn, N. Y.
Cartwright, Matt., - -	Rochester, N. Y.
Cartwright, Wm., - -	Oswego, N. Y.
Chadwick, H. J., - -	Lockport, N. Y.
Chambers, John S., - -	Trenton, N. J.
Chollar, Byron E., - -	Topeka, Kan.
Clark, Walton, - - -	Philadelphia, Pa.
Coggeshall, H. F., - -	Fitchburg, Mass.
Collins, A. P., - - -	New Britain, Conn.
Connelly, J. S., - -	New York, N. Y.
Connelly, T. E., - -	New York, N. Y.
Cooper, Arthur F., - -	Exeter, N. H.
Cornell, Thomas C., - -	Yonkers, N. Y.
Cowdery, Ed. G., - -	Milwaukee, Wis.
Crafts, David W., - -	Northampton, Mass.
Cressler, A. D., - -	Fort Wayne, Ind.
Curley, Thomas, - -	Wilmington, Del.
Cushing, Oliver E., -	Lowell, Mass.
Daly, David, - - -	Jersey City, N. J.
Davis, Frederick J., -	Waltham, Mass.
Dell, Jno., - - -	St. Louis, Mo.
Denniston, W. H., - -	Pittsburg, Pa.
Diall, M. N., - - -	Terre Haute, Ind.

Dickey, Charles H.,	Baltimore, Md.
Dickey, R. R.,	Dayton, Ohio.
Down, William H.,	New York, N. Y.
Faben, Charles R., Jr.,	Toledo, Ohio.
Findlay, J. H.,	Ogdensburg, N. Y.
Flemming, Dudley D.,	Jersey City, N. J.
Floyd, Fred W.,	New York, N. Y.
Floyd, Henry E.,	New York, N. Y.
Fodell, William P.,	Philadelphia, Pa.
Gardner, James, Jr.,	Pittsburg, Pa.
Gardner, William,	Pittsburg, Pa.
Gartley, Wm. H.,	Philadelphia, Pa.
Gates, Frederick Wm.,	Hamilton, Ont.
Gibbs, W. W.,	Philadelphia, Pa.
Gibson, Wm. H.,	Lima, Ohio.
Gilbert, Thomas D.,	Grand Rapids, Mich.
Glasgow, Arthur G.,	Kansas City, Mo.
Goodwin, W. W.,	Philadelphia, Pa.
Gordon, J. J.,	Cincinnati, Ohio.
Graeff, Geo. W., Jr.,	Philadelphia, Pa.
Gribbel, John,	New York, N. Y.
Griffin, John J.,	Philadelphia, Pa.
Hallett, J. L.,	Springfield, Mass.
Hambleton, F. H.,	Baltimore, Md.
Hanford, L. C.,	Norwalk, Conn.
Harbison, John P.,	Hartford, Conn.
Hayward, Thos. J.,	Baltimore, Md.
Helme, William E.,	Philadelphia, Pa.
Hookey, George S.,	Augusta, Ga.
Hoover, C. E.,	Winchester, Va.
Hopper, Thos. C.,	Germantown, Pa.
Hopper, William H.,	Germantown, Pa.
Humphreys, Alex. C.,	Philadelphia, Pa.
Humphreys, C. J. R.,	Lawrence, Mass.
Jones, Edward C.,	South Boston, Mass.
Krumholz, Joseph,	Buffalo, N. Y.
Kuehn, Jacob L.,	York, Pa.
Lamson, Charles D.,	Worcester, Mass.
Lansden, Thomas G.,	Washington, D. C.

Leach, Henry B., - -	Taunton, Mass.
Learned, E. C., - -	New Britain, Conn.
Learned, Waldo A., - -	Newton, Mass.
Lindsley, Edward, - -	Cleveland, Ohio.
Littlehales, T., - - -	Hamilton, Ont.
Loomis, Burdett, - -	Hartford, Conn.
Lynn, J. T., - - -	Evansville, Ind.
Mayer, Frederick, - -	Baltimore, Md.
McCleary, Alex. J., - -	Philadelphia, Pa.
McDonald, Wm., - -	Albany, N. Y.
McElroy, Jno. H., - -	Pittsburg, Pa.
McIlhenny, John, -	Philadelphia, Pa.
McMillin, Emerson, - -	St. Louis, Mo.
Milsted, Wm. N., - -	New York City.
Monks, Richard J., - -	Boston, Mass.
Mooney, William, - -	New York, N. Y.
Moore, David, - -	Salem, Mass.
Nettleton, Charles H., - -	Birmingham, Conn.
Newell, Jno. W., - -	New Brunswick, N. J.
Nute, Jos. E., - - -	Jersey City, N. J.
O'Brien, Wm. Jno., -	Philadelphia, Pa.
Odiorne, Fred. H., - -	Boston, Mass.
Page, Geo. Shephard, -	New York, N. Y.
Park, William K., - -	Philadelphia, Pa.
Parrish, William, - -	Seneca Falls, N. Y.
Pearson, William H., - -	Toronto, Ont.
Perkins, James D., - -	New York, N. Y.
Perry, A. D., - - -	Lynn, Mass.
Pratt, Edw. G., - -	Des Moines, Iowa.
Prichard, Charles F., - -	Lynn, Mass.
Quinn, A. K., - -	Newport, R. I.
Ramsdell, George G., - -	Vincennes, Ind.
Rogers, James F., - -	Jamaica Plain, Mass.
Rowland, Charles L., - -	Brooklyn, N. Y.
Rowland, William L., -	Philadelphia, Pa.
Rusby, Jno. M., - -	Jersey City, N. J.
Russell, D. R., - -	St. Louis, Mo.
Scriver, J. F., - - -	Montreal, Canada.
Shelton, Fred'k H., -	Philadelphia, Pa.

Sherman, B. F.,	- -	Boston, Mass.
Sherman, F. C.,	- -	New Haven, Conn.
Sisson, Frank N.,	- -	Albany, N. Y.
Slater, A. B.,	- -	Providence, R. I.
Slater, A. B., Jr.,	- -	Providence, R. I.
Smallwood, James B.,	-	Baltimore, Md.
Smith, Marcus,	- -	Wilkes Barre, Pa.
Smith, Orlando F.,	-	Washington, D. C.
Smith, Robert A. C.,	- -	New York City.
Snow, W. H.,	- -	Holyoke, Mass.
Sprague, Charles Hill,	- -	Boston, Mass.
Spaulding, Charles F.,	-	Waltham, Mass.
Spaulding, Charles S.,	- -	Brookline, Mass.
Starr, James M.,	- -	Richmond, Ind.
Stein, E.,	- - -	Philadelphia, Pa.
Stiness, Samuel G.,	-	Pawtucket, R. I.
Taber, Robert B.,	- -	New Bedford, Mass.
Thomas, Joseph R.,	-	New York, N. Y.
Thompson, James D.,	- -	St. Louis, Mo.
Townsend, S. S.,	- -	New York, N. Y.
Tufts, Nathaniel,	- -	Boston, Mass.
Turner, Thomas,	- -	Charleston, S. C.
Vanderpool, Eugene,	- -	Newark, N. J.
Wagner, Louis,	- -	Philadelphia, Pa.
Warmington, G. H.,	- -	Cleveland, Ohio.
Watson, Charles,	- -	Camden, N. J.
Weber, Oscar B.,	- -	New York City.
White, Wm. Henry,	-	New York, N. Y.
Wilcox, H. K.,	- - -	Middletown, N. Y.
Wood, Gideon,	- -	New Bedford, Mass.
Wood, Walter,	- - -	Philadelphia, Pa.
Young, John,	- -	Allegheny City, Pa.
Young, Robert,	- -	Allegheny, Pa.

Associate Members.

Norton, H. A.,	- -	Boston, Mass.
Persons, F. R.,	- - -	Chicago, Ill.
Van Wie, P. G.,	- -	Cleveland, Ohio.

REPORT OF COUNCIL ON LAST YEAR'S APPLICATIONS FOR MEMBERSHIP.

At the meeting at Toronto, last year, there was some question as to the application of the new Constitution to the elections of members that were then held, and it was referred to the Council to take decisive action; and by vote the Council were instructed to make valid the elections, if there was not an election, by electing those gentlemen to membership. The Council, therefore, present this report :

To the Members of the American Gas Light Association :

In accordance with the vote passed at the last meeting, your Council recommend that the election of a year ago of the following gentlemen be confirmed :

Active.

Chadwick, H. J.,	Lockport, N. Y.
Thomas, Mark B,	Dundas, Ont.
Stoddard, C. H.,	Brooklyn, N. Y.
Pearson, W. H., Jr.,	Toronto, Ont.
Higby, W. R.,	Bridgeport, Conn.
Slater, A. B., Jr.,	Providence, R. I.

Associate.

Wilson, W. I.,	New York, N. Y.
Norton, H. A.,	Boston, Mass.
Persons, F. R.,	Chicago, Ill.
Van Wie, P. G.,	Cleveland, Ohio.
Wright, W. S,	Chicago, Ill.

For the Council,

C. J. R. HUMPHREYS,

Secretary.

On motion of Mr. Stiness the recommendation of the Council was approved, and the election of the members named confirmed.

ELECTION OF NEW MEMBERS.

The SECRETARY—The Council further report their approval of applications for membership, as follows:

To the Members of the American Gas Light Association:

The Council having approved of the following applications, respectfully submit them to the Association for action:

Active.

*Anderson, Wm.,	Marlboro, Mass.
*Eichbaum, F. H.,	San Francisco, Cal.
*Vail, R. B.,	Rahway, N. J.
*Forbes, James,	Chattanooga, Tenn.
*Welsh, William L.,	Oswego, N. Y.
*Harper, George H.,	Fall River, Mass.
*Norris, Rollin,	Jersey City, N. J.
*Littleton, A. W.,	Quincy, Ill.
Spaulding, W. F.,	Clinton, Mass.
*Butterworth, Irvin,	Columbus, Ohio.
Evans, Charles H.,	Jackson, Mich.
*Bradley, Fred. L.,	New York City.
Wood, William A.,	Boston, Mass.
Bailey, Charles B.,	Washington, D. C.
*Franklin, S. J.,	Warren, Pa.
*McCutcheon, James,	Allegheny, Pa.
*Lysle, Addison,	Pittsburgh, Pa.
*McDonald, William,	Philadelphia, Pa.
*Miller, A. S.,	Omaha, Neb.
*Egner, Frederic,	St. Louis, Mo.
*Hostetter, D. Hubert,	Pittsburg, Pa.
*Slaney, H. C.,	New York City.
*Cornell, A. B.,	Youngstown, Ohio.
*Carroll, Francis,	New Orleans, La.
*Mitchell, K. M.,	St. Joseph, Mo.

Associate.

*Logan, William J.,	Brooklyn, E. D., N. Y.
*Barrows, W. E.,	Philadelphia, Pa.

* Present at this meeting.

*Rice, F. B., - -	New York City.
Oakman, Richard N., - -	Greenfield, Mass.
*Sumner, Robert N., -	Philadelphia, Pa.
*Ossius, George, - -	Detroit, Mich.
*Conant, Ed., - -	New York City.
*Crane, Wm. M., - -	New York City.
*Stratton, S. S., - -	Chicago, Ill.
*Walsh, R. D., - - -	St. Louis, Mo.

THE PRESIDENT—What action will you take with regard to these applications for membership? The ordinary way is to authorize the Secretary to cast the ballot of the Association.

On motion of Mr. Harbison the acting secretary cast the ballot of the Association for the above named gentlemen, who were then declared duly elected.

THE PRESIDENT—If the gentlemen who have just been elected to the Association, are present, they will please rise. (The members were then introduced.)

The next business is the reading of the Report of the Council on the workings of the Association during the last year, which will be read by the Secretary.

REPORT OF COUNCIL.

BALTIMORE, MD., October 15th, 1889.

To the Members of the Association :

Your Council would respectfully offer the following report on the work of the Association for the past year:

More than the ordinary amount of routine work has been performed during the year. Volume 8 of the Proceedings, comprising the record of the 1887 and 1888 meetings has been published in book form, similar to the volumes previously published. There has also been published a General Index to all the volumes of the Proceedings, including that last issued. This involved, first, the preparation of an index to Volume 1, which was not indexed originally.

In the list of members annexed to Volume 8 will be found dates showing when each person was elected to membership.

* Present at this meeting.

The preparation of these dates has involved a great deal of research among the early records of the Association, and the task was the more difficult because at the outset the membership was made up of gas companies and not individuals, then, later, these companies named their representatives, who were thereafter considered members.

The Council has also made arrangements to carry out the wishes of the Association by having the papers printed in advance of each meeting. We regret that each year a few of the papers are held back so long as to prevent their being printed before the Convention.

The permanent gold badge prepared under the direction of the Badge Committee has been sent to the members within the last few weeks. These were all sent out by registered mail to ensure their safe transmission.

The Council has approved the following papers to be read during the meeting:

"Fuel Gas," by Walton Clark; "Care and Operation of Gas Holders," by C. L. Rowland; "Illuminating Water Gas—Past and Present," by F. H. Shelton; "Leakage and Condensation," by E. C. Jones; "Purification of Gas from Kansas Coals," by B. E. Chollar; "Conduct of the Electric Light Business in Connection with the Gas Industry," by W. H. Pearson; "Advantages of Supplying a mixture of Coal and Water Gas," by T. G. Lansden; "Some Thoughts on Fuel Gas, Induced from Practical Experience in the Distribution of Natural Gas," by John Young, and "Gas Calorimetry," by Prof. E. G. Love.

The Council hoped to have been able to present a paper, from Mr. H. C. Adams, on "American Gas Coals," but we regret that ill-health and press of many duties have prevented that gentleman from preparing his essay.

The Council have appointed the following gentlemen to serve as the Committee on Nominations, viz.:

Chas. H. Nettleton, Birmingham, Conn.; Ed. Lindsley, Cleveland, Ohio; D. H. Geggie, Quebec, Canada; Geo. S. Hookey, Augusta, Ga.; Ed. G. Cowdery, Milwaukee, Wis.

The duty of this Committee is to bring before you a list of nominees for officers to serve for the ensuing year.

[redacted]

The Council recommend that Edmund T. Davis be appointed the Official Stenographer of the Association.

The Council recommend that hereafter the Association take its own report of the meetings (as at present) and furnish the gas papers with a copy, at the expense only of the cost of making said copies.

For the Council,

C. J. R. HUMPHREYS,

Secretary.

The Finance Committee have approved the accounts of the Treasurer, as per report attached.

For the Council,

C. J. R. HUMPHREYS,

Secretary.

REPORT OF FINANCE COMMITTEE.

To the Council of the American Gas Light Association:

Your Finance Committee have examined the books and vouchers of the Secretary and Treasurer, C. J. R. Humphreys, for the year ending September 30, 1889, and find the same to be correct.

WM. HENRY WHITE,
A. E. BOARDMAN,
GEO. G. RAMSDELL,

Finance Committee.

On motion of Mr Stiness, seconded by Mr. Harbison, the Report of the Council was accepted and the recommendations therein made adopted

REPORTS OF TREASURER AND SECRETARY.

The following reports of the Treasurer and Secretary, for the year ending September 30, 1889, were, on motion, accepted and placed on file

TREASURER'S REPORT.

Receipts.

Dues for year of 1886	$15.00	
" " 1887	70.00	
" " 1888	210.00	
" " 1889	1,265.00	
" " 1890	500.00	
Initiation fees	270.00	
Sale of books	19.25	
Account of Stenographic Report of Toronto Meeting	96.84	
Interest	104.56	
Total	$2,550.65	
Amount brought forward from last year	2,862 95	
		$5,413.60

Expenditures.

Expenses Toronto Meeting	$192.63	
Salary of Secretary and Treasurer	600.00	
Printing of Stationery	221.66	
Stamped Envelopes, Stamps and Sundries	760.17	
Expenses of Council and Committee Meetings	178.88	
Printing Volume 8 and General Index to Vols 1 to 8	1,140.00	
Badges—450—also, samples	1,832.00	
Expenses of Reporting Toronto Meeting	290.50	
	$5,215.84	
Amount carried forward to next year	197.76	
		$5,413.60

Due from Members $1,785.00

Examined and found correct.

WM. HENRY WHITE,
A. E. BOARDMAN,
GEO. G. RAMSDELL,
Finance Committee.

SECRETARY'S REPORT.

Number honorary members on roll, Oct. 1, 1888	7
Died during the year	1
Number on roll Oct. 1, 1889	6
Number of active members on roll Oct. 1, 1888	333
Admitted Oct. 1, 1888	22
Total	355
Resigned during the year	8
Dropped " " "	4
Died " " "	5
Number on roll Oct. 1, 1889	338
Total	355

Associate.

Associate members admitted Oct., 1888	5
Number on roll, Oct. 1, 1889	5

DECEASED MEMBERS.

Honorary.

R. P. Spice .... London, England.

Active.

John Cartwright .... Poughkeepsie, N. Y.
C. F. Maurice .... Sing Sing, N. Y.
[redacted] .... [redacted]
C. H. Nash .... St. Joseph, Mo.
J. H. McDougall .... Hornellsville, N. Y.

REPORTS OF SPECIAL COMMITTEES.

THE PRESIDENT: The next business is the reading of the reports of special committees. Has any Chairman of a special committee a report to make?

REPORT OF COMMITTEE ON BADGES.

MR. NETTLETON—On behalf of the Committee on Badges, I will say that we have made our report, and that the badges are in the hands of the members of the Association. When we reported a year ago, the committee agreed that designs should be obtained from several manufacturing jewelers. A number of designs were obtained, and we tried to agree upon one; but, finally, thinking that we could get more satisfactory results if we could judge from the badges themselves, we had a number of sample badges made, and after a good deal of effort and time the committee were able to agree on a certain badge. This was shown to the President and Secretary of the Association, and they agreed with the committee that it was perhaps as well as we could do for the money, and the badges were ordered. They cost $4.50 each, and the committee hope that the Association are satisfied with what they have done.

MR. HARRISON—I move that the report of the Committee on Badges be accepted and the committee discharged, with the thanks of the Association for the thoroughness with which they have attended to their duties. (Adopted.)

REPORT OF COMMITTEE ON STANDARD UNIONS.

MR. DOWN—As Chairman of the Committee on Standard Unions I will state that the committee are prepared to make a report. We have had several meetings of the committee, and have had a great deal of trouble in trying to agree upon some standard. We have finally agreed upon the standards, and trust that our recommendation will meet with your favor. Mr. Goodwin will read the report of the Committee.

Mr. Goodwin read as follows:

The Committee on Standard Unions beg leave to present the following report:

At the last meeting of the Association, held in the city of Toronto, standards for 3, 5 and 10-lights were adopted by the Association, and the committee were continued with instructions to report further standards at this meeting, and now present the following sizes for your consideration and adoption, viz.:

20-light, $11\frac{1}{2}$ threads; diam. of screw, $1\frac{63}{64}$: diam. of tail piece, $1\frac{24}{64}$: diam. of nose, $1\frac{29}{64}$.

30-light, $11\frac{1}{2}$ threads; diam. of tail piece, $1\frac{37}{64}$; diam. of nose, $1\frac{32}{64}$; diam. of thread, $2\frac{2}{64}$.

45-light, $11\frac{1}{2}$ threads; diam. of tail piece, $1\frac{59}{64}$; diam. of nose, $1\frac{45}{64}$; diam. of thread, $2\frac{17}{64}$.

60-light, $11\frac{1}{2}$ threads; diam. of tail piece, 2"; diam. of nose $1\frac{58}{64}$; diam. of thread, $2\frac{28}{64}$.

80-light, $11\frac{1}{2}$ threads; diam. of tail piece, $2\frac{8}{64}$; diam. of nose, $2\frac{5}{64}$; diam. of thread, $2\frac{49}{64}$.

100-light, $11\frac{1}{2}$ threads; diam. of tail piece, $2\frac{31}{64}$; diam. of nose, $2\frac{14}{64}$; diam. of thread, 3".

Your committee would also report that they have had prepared "Standard Gauges" for 3, 5 and 10-light meters, and each manufacturer now possesses one set each, and we have presented a set to the Association, which have been deposited with the Secretary for reference. These gauges were manufactured by the Pratt-Whitney Co.

Your committee would also state that since the adoption of the 3, 5 and 10-light standards orders for meters with Standard Unions have not been received as freely as was expected. We, therefore, respectfully suggest that the 1st day of March, 1890, be named as the date from and after which all meters ordered shall be furnished with Standard Unions adopted by this Association, unless expressly ordered otherwise.

All of which is respectfully submitted,

W. H. Down, *Chairman.*

Mr. Goodwin—If this report is adopted, the members of the different manufacturing firms are prepared to furnish the Association with the standards, and they would like to know your pleasure with regard to other sizes.

The President.—You have heard the report of the Committee on Standard Unions; what will you do with it?

Mr. Harbison—I move that the report of the Committee on Standards be accepted and approved, and that the recommendations be adopted by this Association.

Mr. Walton Clark—I wish to add to that motion that we give the committee a hearty vote of thanks for the pains they

have taken and the expense they have been to in order to provide us with standard unions. Every man who has ever set a meter knows the value that uniform standards will be to the Association. I therefore move a hearty vote of thanks to the committee.

The President—You have heard the motion of Mr. Harbison and the remarks of Mr. Clark.

Mr. Harbison—It should be understood that as their work is not completed the committee are to be continued in office. My motion, therefore, is that we accept the report of the committee as made, and that the committee be continued in order that they may carry on and complete the work that they have undertaken. (Adopted.)

ELECTION OF OFFICERS.

Mr. Nettleton—The Committee on Nominations have had but two meetings, but they have agreed to recommend the following gentlemen as officers of the Association for the ensuing year:

For President—Emerson McMillin, St. Louis, Mo.

For Vice Presidents—Jno. P. Harbison, Hartford, Conn.; Wm. H. White, New York; A. E. Boardman, Macon, Ga.

Secretary and Treasurer—C. J. R. Humphreys, Lawrence, Mass.

Members of Council for one year—Wm. H. Pearson, Toronto, Ont.; Geo. G. Ramsdell, Vincennes, Ind.; Chas. W. Blodget, Brooklyn, N. Y.; B. E. Chollar, Topeka, Kansas.

Members of Council for two years—S. G. Stiness, Pawtucket, R. I.; Walton Clark, Philadelphia, Pa.; Chas. R. Faben, Jr., Toledo, O.; Thos. G. Lansden, Washington, D. C.

The President—What will you do with the report of the Committee on Nominations?

Mr. White—I move that it be accepted, and that Col. Thomas cast the ballot of the Association for the election of the officers, as named.

Mr. Thomas—I cast the ballot of the Association for the gentlemen named as officers for the coming year.

The President—By unanimous vote the officers named are

elected, and they are declared to be the officers of the Association for the ensuing year. Is Mr. McMillin present?

Mr. Egner—Mr. McMillin told me that he could hardly hope to be here, as his family are going to Europe to stay for some time; but that he would get here if he possibly could.

Mr. Harbison—I move that the Secretary be directed to telegraph to Mr. McMillin and announce to him his election as President of the Association for the coming year. (Agreed to.)

The President then read the following address:

PRESIDENT'S ADDRESS.

Gentlemen of the American Gas Light Association:

We come to this, our Seventeenth Annual Meeting with mutual congratulations that the great industry which we represent still remains in a prosperous condition throughout the country, notwithstanding the fact that we have had to meet such competition in the supplying of artificial light as has never before been known in the history of the business.

There are very few companies whose books do not show an increase in the quantity of gas distributed, and this increase is generally the greatest in the larger cities where competition is the most active. This fact alone furnishes ample evidence that illuminating gas of good quality still holds the confidence of our consumers, and that no other illuminating agent is yet able to furnish an equal quantity of light for a given sum of money, and at the same time be as sure and safe a dependence to the public, and pay a fair return upon the capital which is necessary to carry on the business. From these facts we would naturally expect to see renewed confidence in the future and permanency of the business, and this is shown in the activity which we everywhere see in the expenditure of large sums of money for the enlargement and extension of the business, by the construction of new and improved apparatus and machinery, larger gasholders, mains, etc. New and improved apparatus and machinery, with better facilities and better management, result in reduced cost of production, which enables us to reduce the selling price of gas, and that means increased sales, which, in turn, adds another element of economy in cost of manufacture. A gas company

that means to hold its present business and increase it, will not be too slow in adopting improved methods and machinery when economy of manufacture is sure to result from their use.

One of the objects of this Association is to facilitate the interchange of information and knowledge among the members which may enable the companies to take advantage of improvements in manufacture. To be more explicit, our Constitution reads, "The object of this Association shall be the promotion and advancement of knowledge, scientific and practical, in all matters relating to the construction and management of gas works and the manufacture, distribution and consumption of gas. The establishment and maintenance of a spirit of fraternity between the members of the Association, by social intercourse and by friendly exchange of information and ideas on the before mentioned subject matters, the inducement and extension of more cordial and friendly relations between the manufacturers of gas and their patrons, based upon the mutuality of interests."

The public may look upon this Association as being a gigantic combination of monopolists, a sort of Trust, whose sole object is to devise some scheme to bull the price of gas throughout the country. On the contrary, the object and nature of this Association preclude the possibility of a member taking any action or doing anything which in any manner by such act can bind a single company represented here. It is not an Association of gas companies, but of individuals, and no member is authorized or empowered by his Board of Directors to perform any act as a member of this Association to bind the company which he represents. At the most, he can only recommend to his directors that a certain action be taken or a certain policy be adopted, not because of any action of the Association, but solely because of information and knowledge acquired by attendance at our meetings.

In the early days of gas manufacture in this country we had no educated or experienced gas engineers or managers, and it was quite natural that the forms and regulations of older countries should be adopted for guidance. "Cast iron rules and regulations" were generally adopted and observed to the letter, and when the officer, whose duty it was to see that the rules and

regulations were carried out, happened to be a person of morose nature, without a pleasing manner or address, a result disagreeable to both parties would follow, only to be repeated day after day; and then we wonder why such ill feeling exists towards gas companies.

Certain rules and regulations may be necessary to the successful prosecution of the business of any large establishment. While system and order should be observed, officers or clerks whose position places them between the public and the company, particularly when that company happens to be a gas company, should be persons of good address, of well balanced minds, with ability to control their feelings, especially when the customer happens to be a person of the opposite nature.

We should always take as much pains to treat our customers with politeness as the retail tradesman takes to please his customers. The latter realizes that others in the same line of trade would take his customers' business if he fails to satisfy them, and the nature of our business makes it all the more necessary for us to exert ourselves in this direction. Our customers are extremely sensitive to the fact that they are obliged to patronize us if they use gas, so that when a customer, from what he may consider ill treatment, leaves us in a disagreeable frame of mind, it instantly begets in him a desire for an opposition gas company, while he is entirely oblivious to the fact that another gas company would furnish the same kind of gas, sell it by meter measure, and transact its business in a similar way and expect to be paid for the gas supplied.

Such considerations lead us to the conclusion that gas companies should pursue a liberal policy towards their consumers. The old custom of charging the consumer for a portion of the service pipe and expenses of setting the meter, or of compelling him to be at the expense of employing a plumber to connect it, charging rent for the meter, charging for a little attention to pipes or burners—all these petty charges should be abolished. The revenue from these sources at the end of the year does not amount to a large sum of money, while the income from the increased sale of gas derived from new consumers, who may be induced to use gas when they know they can have a service run and meter set without charge, and no expense for meter rent

afterwards, would in most cases be largely in excess of the former.

Our business is to sell gas, and the more we sell, the cheaper we can afford to sell it. The true policy of a gas company is, in the first place, to furnish its customers with a good quality of gas at a reasonable price, and offer liberal inducements for consumers to use it. To this end we should encourage the use of gas engines for power, regenerative burners where a strong light is required, and gas stoves for cooking and heating. Not a single family among our consumers should be without a gas stove for cooking; and they would not be if they knew the value, comfort, convenience and economy of it. Gas companies generally do not take such active interest in this matter as its importance merits. In some places individuals have kept gas stoves for sale, but the high prices which have heretofore ruled for good stoves, together with the little knowledge possessed by the people concerning their utility, has often resulted in small sales. The gas company has an additional interest in the general use of gas stoves over and beyond what any individual can have, because when the gas stove is introduced it secures a good consumer, and from the novelty, saving of labor in starting and caring for the fire, handling of coal and ashes, quickness of action, absence of trouble, comfort of cooking in warm weather and economy in cost, the consumer is both benefited and pleased. Occasionally we find a manager who thinks it an unwise policy for his company to supply its consumers with gas stoves, unless he sells the stoves at a price which yields a profit; and that to lease the stoves at a moderate rental, set and connect them free of cost to the consumer, is a waste of money. Such a policy I regard as shortsighted. In this as in many other matters I think a liberal policy the wisest one. From the fact than we know that a good gas cooking stove can be furnished, set and connected at an average expense of $12 to $14 to the company, I think there is no room for doubt that a gas company can afford to lease such stoves to its consumers at a moderate rental. In some cases, for the purposes of introducing the stoves quickly, I am not prepared to say that it would not be good policy to even give away a few stoves, as from experience we may safely anticipate approximate results. For instance, some managers con-

sider that 12,000 cubic feet of gas may be calculated as a fair average quantity of gas which will be consumed during the season in each stove which is capable of doing the entire work of an ordinary family; but suppose we endeavor to make a safe estimate and call it 8,000 cubic feet; then 1,000 stoves would consume 8,000,000 cubic feet in a year. It is fair to suppose that an order for 1,000 stoves at one time would secure a discount from the regular prices; but these 1,000 stoves could be set and connected at a cost not exceeding $13,000. Now it is very easy to calculate approximate results for any location, and I think it will be found that in most places stoves can be furnished at a moderate annual rental safely and profitably, and in some places they may be actually given away for a time to the profit of the company. Many consumers have little or no knowledge of the proper conditions under which gas should be used for lighting purposes. It is not uncommon to see open burners consuming ten to twelve feet per hour, and giving no more light than should be obtained from six or seven feet per hour. A little attention and instruction given in such cases would avoid much of the dissatisfaction which consumers often bring upon themselves through ignorance of the proper conditions for burning the gas so as to obtain the best results, and this information should be supplied by the gas company.

Whatever we can properly and reasonably do to increase our sales is well, but we should not stop there. We must impress our customers with a feeling of confidence in our motives, and to do this we should interest ourselves in knowing as far as possible that our consumers burn the gas properly and economically. It must not be satisfactory to us to have a consumer use a large quantity of gas, and at the same time know that it is being used in a wasteful and extravagant way, by the use of bad burners which consume a large quantity of gas and at the same time give a light which half the quantity of gas would give him by the use of a good burner. I think any gas company having more than one or two thousand consumers can profitably employ for such work a man of good judgment, one who has the requisite knowledge concerning the proper use of gas to obtain the best results; also the use of regenerative burners in places where they can be used to advantage. A gas company that

simply runs a service pipe, sets a meter and takes no further interest in the consumer does not do its whole duty.

Many of us can remember the time when gas companies made no special effort to increase the consumption of gas; but that day has passed, and the gas manager of to-day, if he is to be fairly successful, must be active and progressive. He must not only supply a gas of good quality for general use and pursue a liberal policy towards the public, but seek by all fair and proper means to popularize the use of gas and increase its consumption. Some companies have done and are doing so, but the time was when cast iron rules and regulations hampered the management and curtailed the sales of gas to a great extent. Until within a few years, competition with illuminating gas was practically unknown, although the discovery and introduction of cheap petroleum oil lessened the natural increase in the consumption of gas. The high price of gas at that time as compared with the present low prices favored the introduction of oil, particularly in those districts in cities where gas was not supplied; but its use entailed inconvenience and such disagreeable odor that customers, unless from circumstances actually obliged to economize, preferred to use gas. Later on the electric light appeared. What followed? The newspapers teemed with statements that led timid holders of gas stocks to dispose of a portion or all of their stock. Prices of gas stocks were depressed. The electric light was heralded as the coming light.

The electric light construction companies were active in their work and in the formation of companies, and the installation of electric light plants, large royalties were demanded. By at least one of the electric light construction companies circulars were actually sent out conveying the intelligence to gas companies that their gas pipes would no longer be required to convey gas to customers for lighting purposes, for the electric light would supply that necessity, and the gas pipes would be used for distributing gas to be used only for fuel purposes. After several years of competition what are the facts? Millions of dollars have been invested in the electric light business. Hardly a city or town of any considerable size in the country that is not to a greater or less extent supplied with electric light. This speaks well for the business enterprise of the electric light people.

Without a doubt many of the companies are earning dividends; some of them are not, even when operated by the local gas company with, as is claimed, less expense than an independent company can do it. With an earnest activity by enterprising men, the business has been pushed to its utmost limit. Contracts have been made for a certain price and for a certain time so as to bind the customer to its use.

Instead of adopting uniform rates and pursuing a policy of treating all customers alike, prices have been offered to suit circumstances and induce the consumer of gas to abandon its use and take the electric light. Some have done so, but few would abandon their old and sure dependence entirely and trust wholly to the electric light. Many private or isolated plants have been established, but not to the entire exclusion of gas. While millions of dollars have been invested in the electric light business, and it has increased with wonderful rapidity, and has, as I said before, reached almost every city and large town in the country, what about the gas business? Has it, with a single stroke of the pen of the electric light man, been wiped completely out of existence? By no means. The gas business was never in a more prosperous and flourishing condition than it is to-day. Never in the history of the business was so much gas distributed as is being done this very year. Gas stocks have the confidence of the investors of money, and the character and business standing of the greater number of the holders of gas stock throughout the country place them among the stable and conservative class. I believe we can afford to be generous enough to give electric light the credit for at least a portion of the progress we have made during the last seven or eight years, and it has been greater than in almost any previous equal length of time.

We furnish a better quality of gas. By improved apparatus and machinery we produce it at less cost. By new and improved burners, especially the regenerative class, we utilize three to four times the quantity of light from a given quantity of gas.

The scientific members of our fraternity have been spurred to greater activity in the line of improvements and inventions, because of the possible competitor which the electric light might prove to be. But we would not endeavor to belittle the

influence of the present or the future of that wonderful mystery in nature, electricity, or its development as an illuminating agent. As scientific men, thoroughly interested in all that pertains to progress in civilization and the welfare and comfort of humanity, we welcome the advent of any invention, or any new adaptation of old principles, to subserve new and useful purposes.

But electricity with all its subtlety can never crowd out that equally wonderful element of nature, gas. The manufacture of gas to be used for the production of light and heat will never be superseded by electricity. The use of gas will be enlarged and extended. Illuminating gas is now extensively used as fuel for domestic purposes, and a gas is demanded which can be economically used for general fuel, not only for domestic, but for all purposes where heat is required.

Much has been said and written advocating a combination of the electric light companies with the gas companies. This may be well for both interests in some places, but I have yet to know of any reasonable or satisfactory argument why, in all cases, it is going to be better for the gas companies. The gas business, as well as the electric light business, will maintain itself upon its own inherent merits. I firmly believe that the business of any gas company will be managed better and will be more prosperous when the manager devotes his whole time, attention and energy to it; and just in proportion as his mind is diverted from it, whether by the electric light or any other business, his gas interest must in some degree suffer from such neglect.

The manufacture and distribution of gas and electricity to be used for lighting purposes are entirely dissimilar. The man who has chosen the gas business for his life work has a field in which the exercise of the brightest intellect, both in the line of scientific investigation and the highest order of business management, can find ample scope, and when his whole mind is concentrated upon his work, success will be more likely to attend him. My observation leads me to believe that bad results have followed already, at least in some instances, where gas companies have taken upon themselves the management of electric light in addition to their own business.

It is said that a gas company can operate an electric light plant and produce electric light at less cost than an independent electric light company can do it. This may in one sense be true, but really, in another sense, it may be at the expense of the gas interest. A glance at the report of the Massachusetts Gas and Electric Light Commissioners reveals the fact that the balance of profit and loss in quite a number of the electric light companies' accounts is on the wrong side of the ledger, showing that the statements often made that the electric light business is always a paying business is open to examination. Nevertheless, electric light has uses for which it is better adapted than gas can be, and for such uses customers can afford and will pay for it a price that will be remunerative to the company that supplies it. Let us not deceive ourselves with the idea that electric light will not have its share of the business of supplying artificial light, or that gas will be crowded out. The field is a broad one, and electric light will share it with us; but, so far, the increased demand for light has become such that we do not, as a rule, notice the inroad that electricity has made when we compare our "send-out" with that of previous years.

I have said that a gas is demanded which can be used economically for general fuel purposes. It has often been shown on paper, but not in a practical way. Many attempts have been made, circulars and advertisements have appeared, which would lead us to think that success had been reached; that gas for fuel could be produced and supplied for all purposes where fuel is required, and at living prices for the manufacturers. The nominal price per thousand feet of fuel gas is not so much the question as the more practical one, can a fuel gas be produced which will do the same amount of work as coal at the same or less cost? I do not mean to say that efforts have not been made to demonstrate that fuel gas can be made and supplied for domestic and mechanical purposes; but the pioneers in this line have not been so successful as to be able to demonstrate that a fuel gas can be made, distributed and used for general fuel purposes at a price that the consumer can afford to pay for it, and at the same time earn a fair return on the investment which is necessary to be made to carry on the business. I do not regard the fuel gas problem as an impossibility, and experiments are now being

made which are claimed to be more or less successful for certain purposes and under certain conditions; but the active gas manager has little time to give to the development of this problem. The theorist has not the opportunity to demonstrate his theories upon a practical scale. We must await the solution of the question, whether certain work can be accomplished by the use of fuel gas at a cost of the solid fuel to do the same work. It is not a little surprising to watch the progress of events and to notice the eagerness with which the visionary minds receive the most absurd statements when coupled with some pretended new invention; and again, to witness the persistence which many so-called inventors will work night and day, literally wasting time and money, in endeavoring to accomplish some result which a little knowledge of well known natural laws and principles would teach them to be impossible. I would not depreciate the efforts of the honest toiler in the field of Science and Mechanism. He may produce something which shall prove a practical benefit to mankind; but how often do we see the "enthusiast," in his haste to become rich or to startle the world by some wonderful discovery, while his pet ideas are yet crude and undeveloped, though printed and circulated in well written pamphlets which abound in extravagant claims that have not been practically demonstrated. A "company" is formed with millions of dollars capital, and no matter how wild the claims set forth, men are found who will invest their money in the scheme. Even if the venture proves unsuccessful, the next one that comes along, promising great profit, will find some waiting to repeat the experiment. Hopeful writers may endeavor to encourage us by giving expression to their feeling of confidence in this or that process by which experiments are even now being made; but we must await the practical demonstration of the actual fact as a commercial success.

I had not intended to trench upon the subjects assigned by the Council to the several writers of papers which will be presented to you at this meeting. The subject of fuel gas will be treated from a technical standpoint by two of our members who are amply qualified to do so, as you well know—Messrs. Walton Clark and John Young—the latter having had a large practical experience in supplying natural gas.

When our Association was formed the President had an opportunity to bring to the Association much information in matters of improvements and experience which would be new to many of the members. Now we have placed before us every week by our several enterprising and ably edited gas journals all the current news pertaining to our business, ably written articles on technical subjects and other matter of an interesting character; and I am fully conscious that the address of your President will be the least instructive part of our procceedings and is likely to be but a repetition of what you are all familiar with. In the several papers which will be read at this meeting you will have subjects discussed which possess more than usual interest and importance. The conduct of the "Electric Light Business in Connection with the Gas Industry," by Mr. W. H. Pearson, is a subject which many gas companies have practically taken up; and the account of the results of their experience will be listened to with interest by all the members of the Association. "Water Gas," by Mr. F. H. Shelton, and "Advantages of Supplying a Mixture of Coal and Water Gas," by Mr. T. G. Lansden, both of whom have had much experience in that direction, will no doubt give us such facts as will aid many of the members in deciding as to the economy or policy of supplying water gas wholly or a mixture of coal and water gas.

Not the least in importance as being vitally connected with the manufacture of gas is "Gas Coals of the United States," which was to have been read by Mr. H. C. Adams, whose knowledge of this subject renders him amply competent to deal with it in a manner that will interest us all. I regret to say that owing to ill-health the writer of this paper desires to postpone it until a future meeting. The "Care and Operation of Gasholders," by Mr. C. L. Rowland, whose experience as a practical designer and constructor of gasholders, thoroughly qualifies him to speak upon his subject with authority and confidence. "Leakage and Condensation," by Mr. E. C. Jones, who is an earnest and devoted student in his profession; and I am sure he will give you some points in connection with his subject that will be new to you. Mr. B. E. Chollar will give you his experience with the "Purification of Gas from Kansas Coals." The purification of gas, although one of the oldest of our subjects, is

one which is always interesting to us, and is receiving the attention of some of the brightest minds abroad as well as at home. I am sure his paper will receive that earnest attention which its importance merits. "Gas Calorimetry" will be treated by Prof. E. G. Love of New York. This is a subject of special interest at this time, and from the experience and reputation of the writer could be placed in no more able hands. These papers will furnish ample subjects for consideration and discussion during the time at our disposal at this session of the Association.

Other topics of hardly less importance might come in for a share of our attention, and one of these is the incandescent gas burner, of which several kinds have been brought to our notice within a few years. Like many other new things they have been heralded as being sure to revolutionize the manner of lighting, and companies for the manufacture and sale of them have been formed with millions of dollars capital, and yet comparatively few of them are in use to-day. There is no doubt that in some degree they possess merit peculiar to themselves, give a soft, mellow and very steady light, and consume comparatively a small quantity of gas; yet, as a rule, they lack one or two fundamental features which any burner must possess if it is to be extensively used; and the first is they lack the elements necessary for the proper and thorough diffusion of light. It is not enough that a burner consumes a small quantity of gas if it does not possess the power to illuminate a space outside of a small circle immediately around the burner itself. Then, some of them must be used with a chimney, which adds trouble and expense; and last, but not least, the first cost of some of them will prevent their universal adoption.

The power of the diffusion of light is another subject which should receive more attention from the young scientific members of our Association than it has heretofore. As I have often remarked none of us can foretell the possibilities for development in our field of investigation, for it is practically illimitable; and how few of us endeavor to reach out and forward into the unknown. Many of us older members have crowded upon us the duties and cares of business management which monopolize our time to an extent which leaves little for continued application

of thought, experiment and work outside of our daily routine of business. But we are already beginning to see a change for the better. Many of the younger members of this Association have been qualified by a thorough technical education to pursue investigation outside of our old and well beaten tracks. The most successful work will be accomplished, not by one whose knowledge is acquired from books only, but by him who is able, with experience in practical work, to bring to his aid the principles and theoretical knowledge which the books and technical schools furnish. This fact has in several instances been brought prominently to my notice by men whose scientific attainments were of the first order, and who could place upon paper the most promising theories, but from lack of practical ability and judgment were seldom able to work them out in practice, and unprofitable results naturally followed.

After practical experience and thorough technical education and training, our several Gas Associations and weekly gas journals place within our reach means for obtaining information and practical knowledge which we cannot afford to ignore. Some of our technical schools are now looking with favor upon the question of establishing a chair of gas engineering. The future usefulness of this American Gas Light Association never looked more encouraging and prosperous than it does now, yet the work accomplished will depend upon the united efforts of all the members. The revision of our constitution has in several important particulars resulted in beneficial changes and added conditions which will tend toward the stability and permanency of our organization. Our membership comprises men who are known at home and abroad as successful managers, scientific investigators, men with years of experience in all the various departments of the business, representative men from all parts of the country, and young men with special education just entering into practical work, and by experience fitting themselves to take the places made vacant by those who by old age or death drop out of the ranks. The condition and prospects of the business of manufacture and supply of gas to be used for light, heat and power were never better than they are to-day.

The same energy, scientific and business ability which has been exercised by our electric light friends during the last

seven or eight years, if concentrated upon invention and improvement in our own business, will show even more marked results than the most sanguine of our members now consider possible. We have the men, material and opportunity; and I dislike to say it, but we need something like the apparent competition of the electric light to spur us into activity in this matter. Until the last few years the conditions of our business were such that we allowed ourselves to drift into carelessness in management, into deep ruts of routine work, and slothfulness from which it will take time to recover.

The most successful managers through the next decade will be those who first read and comprehend the signs of the times, and at once adopt a progressive policy that will lead them to take advantage of acknowledged improvements where possible, and be able to furnish a good quality of gas at a price as low as can be done by any one under the same conditions and in the same locality. I would not be understood as advocating any wild or extravagant policy, but rather the exercise of calm and deliberate judgment, which, coupled with quick perception and comprehensive views of things, distinguish the successful man of the present day from him who, although having an existence in this year of our Lord, 1889, has views of business management which were outgrown and became obsolete twenty or thirty years ago. Competition in any business which has the world for its field means active and energetic work on the part of its promoters and increased sales and cheaper prices. Competition of one gas company with another on a limited field always has and must inevitably result disastrously for both companies and the public, because all the capital which is necessary to invest in works to supply that district with gas is already invested. When the capital is duplicated by an opposition company, then interest must be paid on two capitals out of the same business which the one company originally had, consequently both companies get tired of doing business with little or no profit, and they are compelled to district the territory or combine their interests; and in either case the price of gas cannot be reduced, but must be advanced to pay dividends on both capitals, or the stockholders must be satisfied with a smaller return on their investment. Competi-

tion between gas companies and electric light companies in the supplying of light, heat and power partakes more of the nature of legitimate competition in trade; and yet it does not seem to be so much competition after all, for the electric light seems to have created a field for itself, inasmuch as we know that while electric light is used to a very great extent, yet the quantity of gas called for in growing cities does not grow less, but actually increases year after year.

We may be brought to the test of that imperious law, "the survival of the fittest," to decide whether our business can live and hold its own. I believe it can and will, and outside of the individual work of the members, this American Gas Light Association will be the source from whence shall emanate information and knowledge which will be of material assistance in maintaining our position of furnishing artificial light. The district Associations will aid by performing a share of this work. I am not of that number who have fears that the influence of the work and action of the district Associations will interfere in any detrimental way with the work of this Association. In a paper entitled "Gas Associations and their Mutual Relations," read by our worthy Secretary last May before the Society of Gas Lighting, of New York, he considers this subject somewhat at length and from a standpoint of more intimate knowledge of the real effects of the influence exerted by the different Associations upon each other, and while he therein gives his reason why a certain detrimental influence is at work between the several Associations, yet he expresses my own views when he says: "That there is room for all these Associations there can be no question; for each performs work which the other organizations could not do and fills requirements which would be unfilled did not each Association exist." He then asks for "more systematic and more united action on the part of all the Gas Associations, and suggests that a committee for special work be appointed from this Association to work in conjunction with a similar committee from each of the other Associations. While I am aware that this subject is brought more prominently to his attention by reason of his position and duties as Secretary of this Association than it naturally would be to myself or the other members, yet I feel confident that the

work and influence of the smaller Associations will never seriously interfere with the usefulness of this Association.

In the first place, our membership is largely composed of the more active members of all the other Associations. It does not seem to me that "every year increases the difficulty of obtaining papers, or that the standard of the dissertations is kept up better in the small Associations than in the larger ones;" and while, in his endeavors to secure writers of papers for this Association he has been answered, "No, I cannot write anything for the American Association, because I have to prepare a paper for some other Association, and I feel my first duty to be to my home organization," yet we have no scarcity of valuable papers here at our meetings. The reason, I think, why he feels as he does about this matter is because the principal work of securing papers has fallen upon him, but his efforts have been successful and we have the papers.

I feel that each Association has a field of usefulness for itself, and that each, if composed of active working members, will do its own work independently of the others; and if it is composed of members who do not or will not each do his share of the work, the sooner such an organization drops out of existence the better, and those members who are alive to their work and duty will ally themselves with this or some other Association which will be of some benefit to them and the companies they represent. While we recognize the influence and usefulness of each and all of the district Associations, from its numerical strength of membership, and from its comprehensive character, the American Gas Light Association must be the representative Association of this country; and it is our duty as well as our privilege to take the initiative in any work which is national in its nature and character, and this brings to my mind the suggestion, which I think was first made by President Ramsdell, of the Western Association, in May last, and that is to devise ways and means to have our great industry adequately and fittingly represented at the coming Quadri-Centennial, in 1892. As President Ramsdell remarked, it will be just one hundred years since Murdoch first made a practical use of illuminating gas by lighting his house and premises at Redruth, Cornwall. It will be a most opportune time to have represented the pro-

gress of our business during the past century. This will compare favorably with any of the great manufacturing industries of our time, and an opportunity is offered to commemorate the event in a manner that shall be worthy of the occasion, an opportunity which may never come to us again. As the subject is an important one, I recommend that a special committee be appointed to give the matter proper consideration and report to the Association some plan which, through well directed efforts, may result in something which will be a credit to the memory of past engineers and constructors as well as to those now actively engaged in invention and construction.

In an Association like this, now comprising a membership of more than 350, in the natural course of events, upon assembling together after twelve months have passed, we miss some familiar face and form and that kindly greeting which years of acquaintance at our meetings has made almost sacred. It is sad to know that death has been active in our membership during the past year. Mr. Robert P. Spice, of London, who was elected an honorary member of this Association, at the meeting in Cincinnati, in 1885, died on the 11th day of May last. Mr. Spice was a man of more than ordinary ability and reputation. He was honored in America as well as at home. He served the British Association of Gas Managers as President in 1876-7, and was also a member of several other associations of a kindred nature. All who had the good fortune to become acquainted with Mr. Spice will miss his genial presence at our meetings, and will join his English friends in paying the respect due to the memory of one of our most esteemed associates. Of our active members, three have died during the year, viz: John McDougall, President of the Hornellsville Gas Light Company, Hornellsville, N. Y.; C. H. Nash, President of the Gas Company at St. Joseph, Mo., and John Cartwright, of Poughkeepsie, N. Y. They have been identified with the gas business many years and we shall miss their presence at our annual gatherings. You will commit to kind friends, members of the Association, the duty of preparing a fitting tribute of respect to their memory to be placed upon our records.

Gentlemen, I have taken more of your time than I intended. We have much work before us, and trusting to your kind con-

sideration in the further discharge of my duties, I hope that when the final hour of adjournment comes we may each and all feel impressed that this Seventeenth Annual Meeting has been, as it should be, profitable to us individually, and especially so to the several companies that we represent.

On motion of Mr. White, the President's address was referred to the following committee, for action, with directions to report back to the Association :

A. C. Humphreys, J. P. Harbison and J. L. Hallett.

BRIN'S OXYGEN PROCESS OF PURIFICATION.

The President:—We have with us to-day Mr. E. B. Ellice-Clark, of London. Mr. Ellice-Clark is a member of the Institute of Civil Engineers, and President of the Society of Municipal Engineers. With your permission I will invite him to the platform, and ask him for a few remarks on the Brin oxygen process for purifying gas. (Applause.)

Mr. Ellice-Clark—Mr. President and Gentlemen: I came over to your great country for purposes of recreation, mainly, and I came to this city with a view of seeing and enjoying it for the first time; but when I heard that there was to be a meeting of the Gas Engineers and Managers of America, I knew that I could not more thoroughly enjoy, or more profitably expend my time in Baltimore than by attending this meeting. Certainly I shall go back to the old country very much impressed by the common sense address which I have heard delivered by your President this morning. (Applause.) It has more than ever convinced me of the thorough, sound and common sense view that the Americans take of such practical questions as the manufacture of gas. I hope that the few remarks which I am about to make will be following out one of the principles which your President has laid down. He has said, and said very truly, not only for your country, but certainly for mine, that the gas industry can no longer be left in the hands of incompetent men; that science must be brought to bear in prosecuting this great industry. Now, in England, and no doubt in America, science has for a number of years

been practised in the question of the purification of gas, and I happen, as a civil engineer, to be associated with a process to assist in the purification of coal gas, which has met with a large measure of success in the old country, and that is the process of introducing free oxygen into the gas and continuing the purification by means of lime. I do not know whether the method of obtaining pure oxygen from the atmosphere by the Barium method is well understood in this country, but certainly it is a most practicable process, and, in my judgment, and in that of a number of the scientific men of England, it is one of the most remarkable applications of science ever made; because in the works that we now have in England and one on the Continent, the results tend to show, as it were, a manufactured article passing out of the factory, being sold, and nothing coming in, as the raw material is the oxygen of the atmosphere. I will in a few words attempt to describe the method of separation. It is almost a mechanical process. It is hardly a chemical process, as there is no permanent change in the BaO. The atmosphere is drawn through a purifier of lime to take out the carbonic acid. It is then drawn through caustic soda to eliminate the moisture, leaving only 21 per cent. of oxygen and 79 per cent. of nitrogen passing to a furnace. This air is then drawn through, or rather pushed through a series of steel retorts, hung vertically in a furnace. The retorts are 7 inches in diameter, and may be from 6 to 18 feet in length. They are heated up to about 1400° F., so that there is a series of retorts suspended vertically in a furnace fed by producer gas. These retorts are filled with oxide of barium, obtained from the refuse of lead mines. The baryta is first converted into the nitrate, then into oxide; then broken up into pieces about the size of a walnut and placed in the vertical retorts. The air is drawn through the purifiers, which I have already described, and passes through the retorts. The outlet valve is weighted to 15 pounds above atmospheric pressure. When the oxide of barium is heated to a light cherry red it seizes hold, so to speak, of the oxygen in the atmosphere, and it rejects the nitrogen. Therefore, the nitrogen escapes at the lower end or bottom of the retort into the atmosphere, as free nitrogen, the oxygen remaining in combination with the barium in the retorts. For five

minutes pumping-in takes place; then by an automatic arrangement, the outlet valve for nitrogen closes itself. The pumps are reversed in their action, and the oxygen is forced to a gas-holder. This operation goes on six times every hour for twenty-four hours a day, every day in the week, and it has been repeated upon the same barium now for two years in succession without any deterioration. On the contrary the oxide of barium slightly improves in its capacity for yielding up oxygen. That is to say, we obtain a little more oxygen now from the operation than we did seven or eight months ago. So that the process is a continuous one, and it is an exceedingly cheap one. In fact, in the coal districts of England, oxygen of 90 per cent. purity may be made in a gas works cheaper than coal gas. Now, I come to what no doubt is much more interesting to you, that is, the application of oxygen to the purification of coal gas. I am not a gas engineer, but quite an amateur, as no doubt you will soon find out when I begin to talk about the purification of gas; but any mistakes I am sure you will excuse. If you will refer to Mr. Valon, of Ramsgate (who has now been working on this process for two years consecutively) for explanations of points which I do not make quite clear, he will be glad to enlighten you. The oxygen is passed at about from three-quarters to one per cent. by volume into the crude gas at its entrance to the purifiers. The first experiments were made at Blackburn, by Mr. Ogden, with a special plant. He treated continuously four million cubic feet of gas. The effect of that was that, whereas Mr. Ogden would have had to change one of his purifiers every twenty-four hours, he ran for sixty-eight days consecutively; and in my presence he said that the purifier would have gone on for eighteen months at least. At Manchester, the oxide is taken out of the purifiers for the purpose of reoxidation by the atmosphere, and there is such a large quantity of it that they use two horses and two ploughs to turn it over. Therefore, if it is possible, by the introduction of a cheap gas into coal gas, to practically insure the purification of that gas in closed vessels, a great step has been made in purification. When Mr. Valon was making his experiments he began to make some observations with reference to lime. He used to purify the whole of his gas with oxide; but deter-

mined to throw out the whole of the oxide and to go back to lime purification. Ramsgate is a health resort, and he had abandoned lime purification because the gas works are situated in the center of the town, and the smell of spent lime was very obnoxious, and caused a great deal of trouble when it was removed. Mr. Valon found that not only was the purification effected much more rapidly by using oxygen, but that he only required half of the purifying space. The crude gas at Ramsgate contains 800 grains of sulphur per 100 feet of gas. This was reduced to eight grains. The carbonic acid, I think, amounts to 650 grains, and this is entirely obliterated. But what is more surprising is the increase of luminosity. The coals used at Ramsgate gave 10,000 cubic feet of gas per ton with a luminosity of 15½ candles. For the purpose of revivifying the gas about three-fourths of one per cent. of atmospheric air was used, and the effect of this was to reduce the luminosity by 2½ candles. This luminosity was brought up by the introduction of 2½ to 3 per cent. of cannel coal. When oxygen was introduced Mr. Valon obtained from 3 to 3½ candles of increased luminosity. He thereupon abandoned the use of cannel coal and brought up the gas that he was manufacturing to the normal standard, and more than that, to an additional one-half candle without the use of cannel. So that by introducing oxygen into his gas, Mr. Valon has been able to abandon the use of cannel. He has reduced his sulphur compounds to 8 grains, and he is now carrying on a series of experiments whereby he has thus far ascertained that he can make, instead of 10,000 cubic feet of gas per ton of coals he will probably get from 11,000 to 12,000, and still serve customers with gas of the same luminosity and of increased purity.

I am not going to detain you with any more remarks on this subject. I have given you the result of the experiments that have been made by Mr. Valon, extending over a period of two years. In coming to your country for the first time, and landing in New York (and even in this city of Baltimore) one cannot but be struck by the enormous advances which electric lighting appears to have made in the United States, and I was exceedingly glad to hear from your President that the gas industry had not suffered thereby. Well, you may look at it

from that point of view; but as a stranger, I cannot but think that if gas in this country had been all that it ought to have been, then the electric light would not have made such strides. That is the impression upon my mind. Certainly in England the electric light has made no such strides as it appears to have made in this country; and fuel being just as cheap with us there is no reason why it should not. I may be wrong, but my own opinion is that the reason why the gas industry in England has held its own, and will continue to hold its own against the electric light, is by reason of its economical production and the great care that English and Scotch engineers devote to their business. First of all, we do, by Parliament and by Statute, what competition will, I think, compel you to do in this country. As most of you are aware, the gas companies in England are compelled to keep their sulphur compounds down to the lowest known practicable limit. They are obliged to give gas of a certain candle power; and in London at a certain price. Therefore, being compelled to do this, they not only do it, but do a great deal more. For, whereas the Statute says that they shall give gas of 16 candles, very often the mean luminosity is 17 or 18 candles. The fact is that the gas engineers, by these statutes, have been put upon their mettle, and now they make and deliver gas cheaper, and of better quality, and of higher luminosity than is required by any statutory regulations. Therefore, the electric light engineers have a much stronger competitor to deal with there than they have here. My impression may be wrong, but I cannot but feel that if all the gas companies in this great country were working on the same line —delivering to their customers, gas at a low price, gas of a standard luminosity, and of a standard quality of purity, and if they had adopted the best known practicable means for attaining this, you would not have so much to fear from the electric light. This, as we always say in England, is a free country, and one is very glad to form the impression that you will do by open competition that which in England has been forced upon them by Act of Parliament. (Applause.)

I am very much obliged to you for your kindness in allowing me to address you.

Mr. Jones—I would like to ask Mr. Ellice-Clark one question: In taking the air from those retorts, what vacuum do you use?

Mr. Ellice-Clark—A 27-inch vacuum.

Mr. Walton Clark—Mr. Ellice-Clark has disclaimed any knowledge of gas matters, and, therefore, it will not be discourteous in me to correct some errors into which I think he has fallen. We know that in England they are confined by Statute to a certain quality and illuminating power of gas. We know that they are allowed a certain number, generally 20 grains of sulphur per 100 cubic feet of gas, and that they are not allowed to go below 16 candles in illuminating power. But we also know that in America without any such regulations, it is rare that you find gas containing more than 12 grains of sulphur per 100 cubic feet, or gas under 18 candle power. (Applause.) The electric competition may not have hurt English gas men as Mr. Ellice-Clark assumes that it has hurt American gas men; but, if so, it is on not account of the quality of the gas; nor is it on account of the price of gas. In England it is true that the gas is made cheaper because of the cheaper labor, cheaper coal, and cheaper materials generally; but those influences affect also the cost of electric lighting.

I would like to ask Mr. Ellice-Clark a few questions as to the Brin process. I have read with a great deal of interest Mr. Valon's recent utterances on this subject, as also the comments which have appeared in some of the American Journals. Mr. Ellice-Clark has not stated, nor has Mr. Valon, whether the absorption of the oxygen is due to the formation of a double oxide, or whether the oxygen is occluded in the barium. This is matter, perhaps, of no great practical interest, but it is of considerable scientific interest. Mr. Valon has said in writing that air will do as well as oxygen, independent of the effect upon the illuminating power of the gas. I would like to ask Mr. Ellice-Clark if he will explain why this is. Mr. Valon did not attempt to explain it, but it may be that his more recent experience has enabled him to do so. It cannot be because of the greater dilution of the gas. If we have 1 per cent. of pure gas we have a dilution of 100 to 1; and if we have 5 per cent. of

air, we have a dilution of 95 to 1, and the difference is not great. Mr. Ellice-Clark has stated also that three-quarters of 1 per cent. of air mixed with Mr. Valon's gas reduces the illuminating power 2½ candles. I believe that that is in excess of what has been found in this country. We have been led to suppose that we could introduce considerable more air than that without reducing the candle power materially. On the gas that they are supplying, that reduction would be from 12 to 14 per cent. of the illuminating power, and if my memory does not fail me, we consider that 1 per cent. of air will reduce not more than 5 per cent. However, I am not certain on that point, but I know that it is very much less than Mr. Ellice-Clark states.

Mr. Ellice-Clark—I do not think that the reaction of the conversion of BaO to BaO_2 is very well understood. The BaO takes up another atom of oxygen when it is exposed to a temperature of 1400° Fahr. under pressure, and it yields it up under a vacuum; and that will go on indefinitely for 20,000 or 100,000 times.

Mr. Walton Clark—Does the temperature remain the same?

Mr. Ellice-Clark—Yes; the temperature is constant.

Mr. Walton Clark—Then it would seem to me that the oxygen was occluded in the material.

Mr. Ellice-Clark—When we first commenced the operation of making oxygen we used a temperature of 600° C. when forcing in the air, and obtained a yield under vacuum at 800°. But after extended observations and experiments by engineers and chemists, we found that we could obtain the oxygen at a constant temperature. I did not mean to say that by the introduction of oxygen in the gas Mr. Valon was able to get 11,000 feet of gas where he only got 10,000 feet from his coals. What I meant to say was that Mr. Valon used to get 10,000 feet of gas from his coals, giving a certain luminosity; but he is now pushing the distillation of coals further and is getting from 11,000 to 11,500 cubic feet. Of course it is of an inferior quality, but the introduction of oxygen in the purification brings up the luminosity. This increased illuminating power has been attributed by those who have investigated the subject to the

higher temperature of the flame by reason of a small quantity of oxygen passing through the purifiers and raising the temperature of the flame at the point of combustion.

MR. PEARSON—I have heard it said that cheaper gas would kill the electric light; but fuller investigation satisfied me that in England it was not the cheap gas that kept out the electric light, but that it was legislation. An electric light company there would have to give up its charter at the end of about ten years. After the company had got itself into good working order and begun to make money, then it would have to give up its charter to the government. Perhaps Mr. Ellice-Clark is not aware that to-day in the city of London the Westinghouse people have introduced one of the largest electric light plants in the world, and expect in a very short time to have it in operation. Moreover, in most of the large hotels in London they are using the electric light because they claim that the gas is so full of sulphur and other impurities that it blackens their decorations. I simply make these statements because I am credibly informed that such is the case; and I have recently heard from a rising gas engineer of very considerable note that incandescent electric lighting is making very considerable headway in the city of London. There was another thing which struck me while Mr. Ellice-Clark was speaking, and that was when he was speaking of the process by which he obtained the oxygen. The question occurred to me—how much does it cost? Bringing it down to dollars and cents, what is the gain obtained per thousand feet of gas, as compared with the present process?

MR. ELLICE-CLARK—The gain is $31 per million feet. The gentleman's arguments are really arguments in favor of gas. He says that he was informed (therefore, he has his information second hand), that the reason why gas was being ousted by the electric light was because of the considerable amount of sulphur contained in the gas. I think that that is perfectly true; and Mr. Valon's investigations enabled him to reduce the sulphur compounds from 20 grains (and in Manchester 35 grains) per 100 feet, to a constant of eight grains. If the hotels to which the gentleman alludes, had been supplied with gas containing only eight grains of sulphur per 100 feet they never would have had electric light. (Applause).

MR. PEARSON—I do not wish to be understood as saying a word against Mr. Valon's process; but I am simply asking Mr. Ellice-Clark as to what was in existence, and as to what caused it. I quite agree with Mr. Ellice-Clark that if there had been less sulphur the result would have been different. But that such is the case I have the most unquestioned authority for the statement that electric lights are used in these hotels very largely on account of the presence of the impurities.

MR. NETTLETON—Mr. Ellice-Clark stated that when Mr. Valon or some other gentleman was using oxide in his purifier that the purifying boxes lasted 68 consecutive days without changing, and that in the opinion of this gentleman it would have lasted 18 months. Then Mr. Ellice-Clark said that Mr. Valon tried to use lime. But he did not say how long the boxes went without changing. I would like to inquire if the boxes of lime would last as indefinitely or for as great a length of time that the boxes of oxide last. If so, it seems to me to be a very important thing for this Association to take up.

MR. ELLICE-CLARK—Mr. Valon states that the boxes with lime would last three times as long with oxygen as they would without oxygen. Not comparing it with the oxide at all, but taking lime without oxygen and lime with oxygen.

MR. LITTLEHALES—I wish to ask Mr. Elice-Clark a couple of questions. The first is if he can give us an idea at what rate per thousand feet the oxygen was introduced; and the second is if the system is practicable in gas works of small or moderate size. With reference to what has been said about the difference in the price of gas in this country and in England, I think the most important element that enters into that question has been lost sight of on both sides, and that is the difference in the capital account. The construction account in this country is very much larger, for there is no such thing as stock watering allowed on the other side. Before a company is started there they are limited very strictly by Parliament as to the capital which shall be employed. A committee of the House of Commons investigates very carefully, and finds out how much capital is necessary for a company in any given locality; and that

limits it. That is a very important element which enters into the consideration as affecting the price of gas.

MR. ELLICE-CLARK—First, as to the cost of oxygen. In England it follows very nearly the cost of coal gas. It depends very largely upon the price of coals. You may take it that whatever it costs to make coal gas, oxygen will always cost about the same. The other question was whether this process is applicable in works of moderate size. Several gas companies or corporations have ordered plants and are putting them up. The smallest is at Shrewsbury, where they want 5,000 cubic feet of oxygen per day. But oxygen may be made economically with a plant for the production of 1,000 cubic feet in 24 hours. That is the smallest plant with which you could produce oxygen economically.

On motion of Mr. Harbison, a vote of thanks was tendered Mr. Ellice-Clark for his courtesy, and for the information given.

AN INVITATION AND TWO LETTERS.

MR. WHITE—We are requested by the local committee to invite Mr. Frank Morrison, the President of an Electric Light Association, to a seat in our body during the meetings of this Convention. If there is no objection, I move that Mr. Morrison be invited to meet with us at his pleasure. [Adopted.]

THE SECRETARY—I have a letter here from the Mayor of Chicago, and also a like letter of invitation from the Committee on Gas Industries for the World's Exposition, of 1892, at Chicago.

THE WORLD'S EXPOSITION OF 1892,
COMMITTEE'S HEADQUARTERS, 183 DEARBORN STREET,
EXECUTIVE COMMITTEE, CHICAGO, Oct. 14th, 1889.

DEAR SIR:—In behalf of the citizens of Chicago, I take pleasure in inviting your Association to hold its annual meeting in 1892 in this City. We would be pleased also to have the International Gas Meeting of 1892 held here at the same time, when we hope to have the World's Fair here.

Yours truly,

DEWITT C. CREGIER, *Mayor of Chicago.*

To the President American Gas Light Association, Baltimore, Md.

THE WORLD'S EXPOSITION OF 1892.
COMMITTEE'S HEADQUARTERS, 183 DEARBORN STREET,
CHICAGO, Oct. 14th, 1889.

President of the American Gas Light Association, Baltimore, Md.

DEAR SIR :—In behalf of the citizens of Chicago we hereby extend to your Association an invitation to hold its annual meeting in 1892 in the City of Chicago. An invitation is also extended to the International Gas Association to hold their meeting in this City at the same time. Ample facilities will be provided for the occasion.

Yours respectfully,

JOSEPH S. WOODRUFF,
CHARLES D. HAUK,
H. D. HARPER,
C. A. VOSBURG,
F. W. WILMARTH,
H. W. WILLARD,

Committee on Gas Industries for the World's Exposition, 1892, at Chicago.

The Association here took a recess until 2.30 P. M.

FIRST DAY—AFTERNOON SESSION.

The Association was called to order at 2.30 P. M.

THE PRESIDENT—The first paper this afternoon will be read by Mr. E. C. Jones, and is entitled

LEAKAGE AND CONDENSATION.

In no other industries are the energies of the manufacturer more devoted to the study of economy than in the manufacture of gas.

Within the gates of the modern gas works the superintendent is actively engaged in developing new methods of reducing the cost of production, by increased regeneration in the furnaces, lengthening the life of purifying material, and endeavoring to make the residual products pay for the coal carbonized, and each success in reducing the cost one-tenth of a cent a thousand feet is hailed with delight, while outside the gates a sum nearly equal to the value of all the fuel used in the works, and equal to four times the cost of purification and nearly equal to

the retort house labor, is going to waste. Is not the subject of leakage of vital importance, and a rich field for the best efforts of the gas manager?

To demonstrate that it does not receive the careful supervision given to other departments of our business, I will quote from King's Treatise. "Let us take the production of gas and the leakage or loss throughout the United Kingdom as it was twenty or twenty-five years ago, and compare them with the production and unaccounted for gas at the present time, and we shall probably find an increase in the actual leakage over that of twenty-five years since, although the percentage of loss is considerably less."

The same unwelcome condition of things probably exists in the United States. The percentage of unaccounted for gas of 56 companies in Massachusetts for the year ending June 30, 1887, was 12.53 per cent., while for the year ending June 30, 1888, the average of 58 companies was 13.17 per cent.

A glance at the following table will convince the most skeptical that the percentage of unaccounted for gas of the companies of the State is increasing instead of diminishing:

	1887.	1888.
Towns with leakage under 5 per cent.	3	3
" " " between 5 and 10 " "	23	16
" " " " 10 " 15 " "	17	23
" " " " 15 " 20 " "	6	8
" " " " 20 " 25 " "	3	6
" " " " 25 " 30 " "	2	1
" " " over 30 " "	2	1

In an era of close competition and small profits it seems a pity that one of the greatest industries of our country is not able to account for a loss, in a single State, of 13.17 per cent. of its product, amounting to over 276 millions of cubic feet of gas, which at 11,000 feet per ton would require over 25,000 tons of coal for its production. In Massachusetts it is evident that the large and increasing leakage is due chiefly to small mains, and the severity of the climate. In looking over the length and sizes of the mains, it is noticeable that the percentage of unaccounted for gas is inversely as the size of the pipe, other things

being equal. To bring the fact clearly before you I have calculated the internal area of the mains of each company (*i. e.*, the number of square feet of iron with which the gas comes in contact). The average main area of each company is 113,629 square feet, and the average area of each mile of pipe is 5,297 square feet. From this we find the average diameter of all mains in the State to be only $3\frac{8}{10}$ inches.

It is a circumstance worthy of consideration that the greater the main area per mile the less the leakage.

No. Companies.	Area per mile of main.	Leakage.
16	Under 4,500 square feet,	14.9 per cent.
8	Between 4,500 and 5,000 square feet,	13.7 "
8	" 5,000 and 5,500 " "	11.8 "
11	" 5,500 and 6,000 " "	10.4 "
10	Over 6,000 square feet,	10.0 "

Another way to demonstrate that small cast iron mains are one of the causes of large leakage would be to ask the members how many pair of clamps were used last winter to repair broken 6, 8, 10 and 12-inch mains, and how many were used for the same purpose on 3-inch mains. In fourteen years I have been called upon but twice to use 6-inch clamps, and I have never had occasion to use larger sizes, while broken 3-inch mains are of common occurrence.

The structure of cast iron is such that the small amount of metal in a pipe three inches in diameter, or less, will not withstand the underground forces of freezing and thawing. The larger pipes are subjected to the same strains, but possess strength to resist them, and do not break. If the unequal expansion and contraction of soils of different degrees of conductivity could be represented in pounds pressure, and the pipe considered as a beam for carrying the load, I think all mains of less than six inches diameter would be of wrought iron. I have entirely given up the use of 3-inch cast iron pipe, and in streets where there is a prospect of a considerable consumption of gas, a six-inch main is laid.

Much has been said of exosmose, or the leakage of gas through the pores of the iron, and I think it is overestimated. One company has 6,022 square feet of area per mile, and a leak-

age of 11.5 cubic feet per square foot per year, while another company has 3,864 square feet of area, and a leakage of 60.6 cubic feet per square foot, showing that if there is any transpiration of gas through the pipe, the amount is very small. Large mains properly cared for, are a preventive of large leakage, and the cost of additional metal used in them, when considered as an insurance against breakage, is a profitable investment, aside from the advantages of large mains for supplying increased demands for gas for engines, heating and cooking.

A brief description of the system of laying mains, testing, and finding leaks, in use in South Boston, may be of interest.

All cast iron mains are laid with cement joints, made by using two hard twisted rolls of lathyarn and a mixture of two parts common cement, one part Portland cement, and one part sand. After the joint is made, it is carefully pointed at an angle of about 45° with quick-setting cement. The joints when prop-

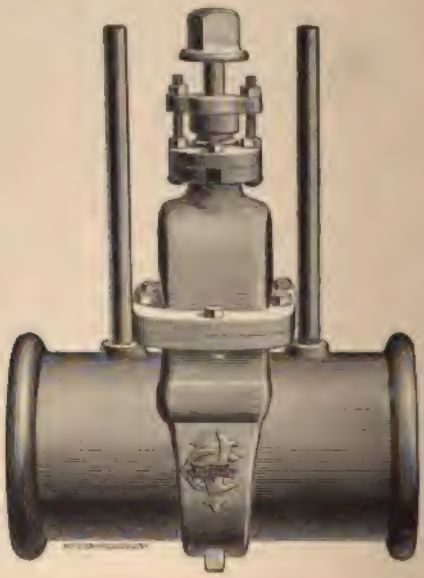

FIG. 1.

erly made are rigid, and fully as strong as any part of the pipe. At each street intersection a long end valve is put in, and on

one side of the valve is a lead joint to allow of expansion and contraction in half of the block. The object in having the lead joints at one side of the section valve, is that they are exposed to view, and any leakage may be quickly discovered upon raising the cover of the valve box. My reason for not using lead joints generally is the belief that all lead joints leak, and it is preferable to have one broken main to having a thousand of

FIG. 2.

small leaks which are not large enough to make their existence known, yet swell the amount of unaccounted for gas.

It has been pointed out to us, as long ago as 1860*, that the difference between the contractile power of iron and lead is as 9 is to 3½. An ordinary engineer's book made of cross section paper, is used to record in the simplest manner the location of each valve, special casting, and lead joint.

In connecting a service pipe with the main, instead of a bend or elbow we use two street elbows. The first is screwed into the main, looking in the same direction the main is laid, and into this the other is screwed, looking at right angles to the main. Two street elbows screwed together in this manner, form nearly a universal joint, making it possible to run the service at any pitch without strain, and allowing for movement of main or service in any direction, without risk of breaking.

Regular and systematic tests of the mains are made by means of a ten-light meter, fitted with a rate dial on the top, and furnished with pipes by which it may be connected with the three-quarter inch pipes on each side of the street valves. The meter is protected against frost or careless handling by being enclosed in a tin box, and the space between the meter and the box is filled with dry sawdust. The tin box is provided with handles by means of which it may be lifted in or out of a wagon. With mains divided into small sections, and a thorough knowledge of each section and the probability of day consumption in each, we are enabled to locate leaks with the greatest nicety.

In districts where gas engines are in use, or where there is known to be a large day consumption, it is necessary to resort to Sunday testing, and it is sometimes desirable to send cards to consumers on a section of main where the meter indicates a leak, or that gas is being used, notifying them that the gas will be shut off for ten minutes for the purpose of testing. When a leak is discovered of sufficient size to warrant further search, we make use of a twisted steel sounding bar, fitted with a loose cross-bar handle. This bar is driven into the ground by means of a sledge, at short intervals, turning as it is driven, until it is near the main, when, on account of its spiral shape, it is easily

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*Report of T. Spencer, *Journal of Gas Lighting*, Sept., 1860.

removed, even from the most closely packed or frozen soil. If it is preferred, a hexagonal steel bar similarly fitted with a wrench handle may be used, and is easily withdrawn. By the well known means of smelling, carefully judging the quantity of gas at each bar hole, and digging where the odor of gas is strongest, the leak is found. Of late I have tested for leaks with some success by means of an aqueous solution of palladium and gold chlorides, prepared from the formula given in a paper by Emil Merz, of Carlsruthe.

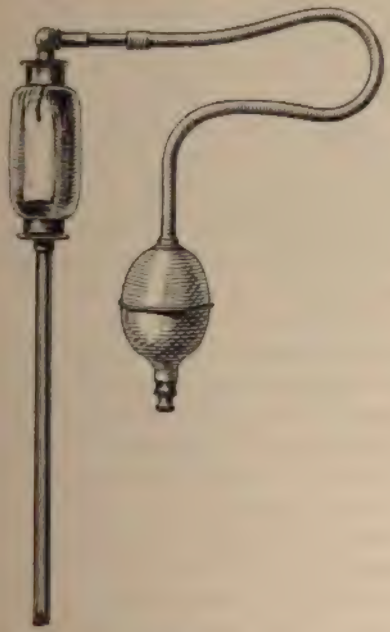

FIG. 3.

The sense of smell is fallible and unreliable, and a solution sensitive to gas, with which test papers may be made for locating leaks with the utmost certainty, is a useful companion in the search for leaks. The solution giving the best results is composed of 3.75 grammes palladium chloride, and 1.25 grammes gold chloride dissolved in 1 liter of distilled water. In Germany where this method of finding leaks has been practiced, it

has been the custom to moisten a slip of filter paper with the solution and insert it in a glass tube, fastened to the end of a piece of iron pipe. After driving a bar, and making a test hole this piece of pipe is lowered into the hole, and if the gas is present, it rises through the pipe, and discolors the test paper. This test occupies fully fifteen minutes, and to save time and increase the efficiency of the test, I have devised a simple piece of apparatus.

A piece of quarter-inch pipe, four feet long, is fitted at one end with a glass bulb six inches long and 1½ inch diameter. This bulb has a removable cap, on the inside of which is a wire hook for holding a slip of test paper. A short piece of rubber tubing connects the cap with a rubber aspirator bulb.

To use this device, the test hole is first made by driving a bar. A slip of paper is moistened with the test solution, and suspended from the hook within the glass bulb. The quarter inch pipe is then lowered into the test hole and by squeezing the rubber bulb the air is exhausted from the apparatus, and if there is gas present in any part of the test hole it is drawn up into the glass bulb, brought in contact with the test paper, producing a reaction, and is expelled through the rubber bulb.

The reaction with this useful reagent commences by the test paper turning a light rose tint, which is followed by a series of drab and brown shades, until it becomes a dark seal brown. The reagent is not extremely sensitive, although it requires some care in handling, and the variety of shades of color accompanying a complete reaction enables the operator to nicely judge the extent and proximity of a leak.

One is well repaid for using this simple test, both by the interest excited by the beautiful reactions, and the fact that unlike the olfactory nerves, it tells a truthful story, and is never tired.

A large portion of unaccounted for gas is directly attributable to the difference in volume of the gas at the temperature at which it is measured at the station meter, and the temperature at which it is sold at the consumers' meters. It is customary at the larger works to record the temperature of the gas at the station meter at frequent intervals, and at the South Boston works the temperature is taken hourly, and carefully recorded.

The measuring temperature of the gas at the largest works in Massachusetts, last year, was 61°, and at South Boston the average measuring temperature was 67.7° F. The question at once arises, the measuring temperature being known, how can we establish a selling temperature?

In my calculation of condensation or shrinkage I have used, as a constant for corrections, a figure nearly representing the mean earth temperature at the depth of three feet, for in moving through the ramifications of underground pipes, the gas will assume the earth temperature at the average depth of the pipes.

To assist me in the study of earth temperature I have had recourse to the reports of the Underground Temperature Committee of the British Association, and I find that in the temperate zones the mean annual earth temperature, at a depth of three feet, does not vary appreciably from the mean air temperature in the same locality. So that the mean air temperature for a year in a given place furnishes a constant with which to correct the volume of gas made, or, in other words, a selling temperature.

Mr. Symons, at the Botanical Gardens, London, found the joint mean of earth temperature taken at depths of 3, 6, 12, 24, and 48 inches, for six years from 1871 to 1876, to be 50.5° F., and the mean air temperature taken at the same time and place 49.6° F. Observations by Quetlet, at Brussels, for three years, make depths less than 1½ feet colder, and at greater depths warmer than the air.

The greatest excess of earth temperature over air temperature is to be found in a series of observations taken in Scotland, where the surface and subsoil were sandy and dry. The air temperature was 46.1°, and the earth temperature at the depth of 22 inches was 48°.

The mean air temperature of Boston for 18 years from 1871 to 1888, was 48.1° F., and I find this does not differ much from the earth temperature at a depth of three feet. The mean earth temperature for five months from January to May, 1889, being 49.1° Fah.

With the temperature of the gas at the station meter and 48.1° Fah., as a constant selling temperature, I am enabled to

find how much of the gas not used by street lights and registered by consumers' meters is actual leakage. For the year 1888 the difference in volume of South Boston gas, thus calculated, was 3.8 per cent., and of the portion of Boston gas manufactured at the North End station, 2½ per cent. condensation due to difference in temperature.

Discussion.

THE PRESIDENT—I think you will all agree with me that this is a very interesting paper and one worthy the fullest discussion. The conditions of condensation and leakage are so variable in different parts of the country that I am sure you will be able to get considerable information from the paper. It is now open for discussion.

MR. SNOW—I would like to ask Mr. Jones if he ever finds his service pipes stopped because of the presence of naphthaline; or if he has found the joints started by rust or dirt settling in the extra joint?

MR. JONES—I have taken out connections of this kind, within a week, which had been in for seven or eight years, and I have not found any of them stopped, even with naphthaline. I have had occasion to lay about 3,500 feet of new ten-inch pipe, and most of the service pipes on the three-inch pipe displaced were *fitted with two street elbows*. I found them in excellent condition, and none of them started.

MR. LAMSON—I would like to ask Mr. Jones if, in using this new form of test for leakage, he has been able in his experience to find any leak which was difficult to be determined by smelling? How much experience has he had in using that test?

MR. JONES—I have not had very much Winter experience with it, but I have used it every time that I have had occasion to look for a leak within the last six months. My attention was called to it by Mr. Nute, of Jersey City, and I took hold of it and found that, by the use of this apparatus, I was able to draw the gas from a place very near the main, up into the bulb and bring it in contact with the test paper, so that if gas is present in any part of the hole I am sure of bringing it in con-

tact with the test paper and thus find out its presence. A few squeezes of the ball exhauts this gas bulb, and the gas or air follows up the pipe and comes in contact with the test paper.

MR. LANSDEN—I would like to ask Mr. Jones what his opinion is with regard to condensation. What proportion of loss does he figure as due to condensation?

MR. JONES—I will say that I am afraid that the subject of my paper, "Leakage and Condensation," may have led members to think that I was going to treat an entirely different subject. Perhaps I ought not to have used the word "Condensation." As it occurs in my paper it refers simply to shrinkage from difference in temperature. I have not enough considered the subject of condensation due to the deposit of the hydrocarbons in the gas to be able to give any information.

MR. LANSDEN—Is it your opinion that most of the loss is due to leakage instead of to condensation?

MR. JONES—My paper says that in South Boston we have a difference of about three per cent. due to shrinkage from difference in temperature.

Mr. TABER—I have made a few figures with regard to the temperature of gas. I live in very nearly the same latitude as Mr. Jones, but I differ with him in finding that the temperature of the air is about 47°, while that of the earth, I find, is a little bit lower than his statement, 57°; and yet I find that the amount of condensation due to the state of the temperature is estimated very closely to his—about three per cent. I was not aware that he was working on those same lines, and I am glad to find that we agree so closely. I think that the three per cent. of loss is not a loss actually, but simply a difference in the measurement affected by temperature.

MR. GILBERT—After some thirty years in the management of small works I have come to the conclusion that our loss of gas is mainly attributable to two faults. One is, not laying pipes deep enough in our colder latitude; and the other is the careless and imperfect work in the making of joints. In the early days of the gas industry, and up to within twenty years, our

superintendents and the men who have charge of that part of the business have largely come from Scotland; and there they generally find it necessary to lay their pipes as deep as we do. I would like to know from gentlemen, and especially from those who live north of Baltimore or New York, and in that latitude, how deep they are in the habit of putting their pipes under ground. My own experience is that it is largely to be attributed to a desire to save expense in the laying of pipes.

MR. SHERMAN—I would like to inquire of Mr. Jones if, in the preparation of this paper, he gave any consideration to the matter of leakage, or the loss which we are subject to, through our consumers' meters. In my opinion we are subject to a very heavy loss in that way. I know of a company in New England which reduced their leakage from 20 per cent. down to 6 by merely looking over and repairing their meters. They had been very much neglected, and, in fact, no attention at all had been paid to them for years; but, by going over them and weeding out those which were not registering at all, and those which were registering 10, 20 or 30 per cent. slow, they succeeded in reducing their leakage from 20 to 6 per cent. My own opinion is that we furnish most of our customers with their night lamps without any pay, that most meters do not register the small quantity which our customers use for night lamps, and that would account for quite a leakage. There is also a great deal of gas which is surreptitiously used. All those things count against the superintendent or manager of the works as leakage.

MR. JONES—I believe that an average test of all the meters in use in New England would be against the gas company. That is they would show slow. I have a company now in mind who are testing all their meters, and they find them slow. A great many meters are 100 per cent. slow, and others are 10, 15 and 20 per cent. slow. In the aggregate they amount to a great deal of gas which the company loses.

MR. STARR—I heartily agree with Mr. Sherman's idea with regard to the leakage of gas. I do not believe that the leakage of gas in the ground is one-twentieth of what it is claimed to be. I believe that one great cause of leakage is the defective meters; and another cause of leakage is the fact that almost all

street lamps burn more gas than they are rated at. I believe that I lose on my street consumption from 15 to 20 per cent., because of the under-rating of the burners. I would rather give the people good burners than to give them small ones. My people pay me my price and I think that I ought to give them a light to suit them. They all say that they have the best lights on our streets that the lamps give anywhere. It answers a very good purpose if you want to renew your charter. We laid a street railroad in our town a few days ago and found a few places where the earth was filled with gas. I thought that there must be a big leak there, and I dug up a number of joints, but there was not a leakage that would burn. We could not find a single point where there was leak enough to show, but still there was a leakage there. I am satisfied that if you have leakage enough to burn even one foot per hour for 24 hours, it will smell on top of the ground. You cannot find a spot in our place where you can smell the gas leaking on top of the ground unless you make a cut. I am satisfied that the leakage goes in the way of imperfect meters, and through these under-rated lights on the street. A case in point occurred last Saturday. A German came to me and said, "You know that I never kick about my gas bills; but I don't know how it is that my bill for last month's gas was $2.50, while this month it is $5.00." Said I, "The only trouble is that you have got a new meter. The old one leaked." The new meter is measuring correctly, and of course the charge is very much larger.

Mr. Littlehales—My own experience corroborates what Mr. Sherman has expressed. I am convinced that a very large percentage of leakage arises from the meters, especially where dry meters are used. We know that it is no uncommon thing for us to find a meter which has ceased registering entirely. That registration does not stop all at once, but it gradually begins to run slow and finally ceases to register at all. Recently I tested a fifty light meter which had been in operation for five or six years, and I found that with five lights it did not register one foot, while with ten lights it was about 20 or 25 per cent. slow; and yet when the maximum quantity was on it was all right. Of course you can understand that in such a case a

great deal of the loss would not be leakage in the proper sense, but simply that you are not getting paid for what you deliver. This loss is due merely to the defective nature of the meter; and it must be so from the very nature of the construction. Of course a careful, periodical examination of the meters will remedy that. The company with which I am connected is subject to a law which provides that every meter must be tested by the Government Inspector every five years. That law has had the effect of giving us a closer examination of our meters; and I think that our small leakage account is largely due to that fact. There is another company that I know of where a great deal of gas is lost because it is overlooked; and that is on account of an old gasholder. Those of us who have gasholders exposed will find sometimes in the summer time that one side of the holder is so hot that yon cannot bear your hand on it, while on the other it is colder, and at the bottom of the holder the water perhaps stands at 40° or 50°. You can easily see that there is a great amount of strain on the holder under those circumstances. There are a thousand-and-one joints and tens-of-thousands of rivets in the holder, and there is a constant tendency to wrinkle the parts one against another; and an enormous amount of gas is lost from the holder which we do not fully appreciate. I was running some large holders awhile ago, and I venture to say that the leakage from those holders would amount to tens of thousands of feet annually. Of course, unless you get near the holder you may not notice the escape, because gas, being light, rises up. But I think that that is one large source of loss. I think that it is between the holder and the meters the loss is due; and that if those two points are attended to the leakage might be brought down to very reasonable limits.

MR. LINDSLEY—I would like to ask Mr. Jones how these cement joints are affected by changes of temperature. There is certainly a change in the length of every pipe by reason of the changes of temperature. I would like to know if his experience has been sufficiently long to enable him to give us any account of the amount of breakage there would be in those joints.

MR. JONES—In my experience I have never known a cement joint, when properly made, to draw. I have never known a properly made cement joint to leak. I have had dozens of cases where the pipe has broken back of the socket without starting the point on the outside of the joint. About six years ago I had occasion to lay about three-quarters of a mile of 6-inch pipe. I instructed my street foreman to lay the pipes as I have described, with valves every 500 feet, and with a lead joint on one side of each valve. The following winter I had two breaks in that 6-inch pipe and main; I dug down, found the pipe parted and was obliged to use clamps, but no joint had started; I then asked my foreman if he followed my instructions; he said that he had not; that he had made that entire length of 6-inch pipe with cement joints, and it was perfectly rigid, but it parted in two places. I dug down to every valve in that length of pipe, ripped those cement joints on the valves, made lead joints and have not had any trouble since.

MR. ANDERSON—I would like to ask Mr. Jones if he considers two parts of cement, mixed with loose sand, makes a sufficiently strong joint?

MR. Jones—I have found that a mixture of one part of Portland cement, one part of sand, and two parts of common cement makes a very strong mixture, and it has given me exceedingly satisfactory results.

MR. ANDERSON—Can you tell what is the tensile strength?

MR. JONES—I have never had an opportunity to test that or to get at the true tensile strength of it, but I would suppose that it was more than cast iron, from the fact that iron pipe breaks back of the socket in various places while the joint does not start.

MR. MCELROY—You are all aware that in the city of Pittsburgh we use the natural gas very largely, and one consequence was that last winter a year ago I had 300 breaks in my main. In those 300 breaks I had one broken joint, and that was at the wall of an old building that extended into the street, and in laying the pipe the men had not taken the wall away, but laid the pipe upon it, and the consequence was that the pipe had fallen

on both sides and had cracked at the joint. That was the only leaky joint of the whole 300 cement joints that I had. My joints are laid with pure Portland and Rosendale, Hawthorne brand cement. I have made joints of the same kind for water pipes, where they have stood a constant pressure of 95 pounds for 9 years and never broke. I have removed, I suppose, from 11 to 12 miles of pipe with lead joints, simply because they were lead joints. I could not endure the stink on the street because of the leakage that came through the lead joints. We could not possibly keep them tight. Any person who has been accustomed to laying lead joints for natural gas in the city of Pittsburgh or vicinity, well knows that there is not 1 in 10 that does not leak. I defy any man to keep a gas pipe joint made of lead for three years. For natural gas I have laid 1¼ miles of 10-inch pipe with cement joints made in the usual manner. The company then sold out to the Philadelphia company and that pipe remained 22 months, delivering gas at their usual pressure. Their manager dug every joint of that pipe from beginning to end and soap-sudsed it, and did not find a bubble. They simply covered up the best of my cement joints with asphaltum and paved the street. Since they did that they have dug up every joint, dug out the cement and filled them with lead, simply because they did not want that kind of evidence in the city that a gas joint could be made tight. [Laughter.]

Mr. Young—I think that it has been established beyond a doubt that a cement joint is the tightest joint yet made ; the only question with me is as to its breakage. They are so rigid that there is no give to them ; and unless there is a lead joint put in every three or four hundred feet, especially in small pipes, you will have a great many breaks. The question is whether it is better to have a great many small leaks than one large leak. My own opinion is, that I would rather have a large broken pipe than a thousand leaking joints. We use nothing but cement. In natural gas it is a little different. There is no trouble about making joints perfectly tight, but if, from any cause the joint is broken in any way, the slightest leak, no matter how small it is, if the natural gas gets in contact with the cement it reduces it to a powder and takes the joint entirely out.

In some districts or sections from where the natural gas comes it carries a certain amount of chloride of sodium, and when that comes in contact with cement it reduces it to a powder. That has been my experience with natural gas. But for illuminating gas it will not act in that way. For illuminating gas I think there is no doubt that the cement joint is the tightest joint yet made.

MR. A. C. HUMPHREYS—This is certainly a very serious subject, and is worthy very full discussion. I am sorry that I was unable to listen to the paper, but shall certainly take great pains to read it carefully. I think probably this is the most serious subject that we have before us as gas engineers, and is perhaps one that we lose the most money in. I should imagine that the first thing any of us would do before starting in to find any heavy leakage would be to determine whether there was a leakage there or not. Undoubtedly, we have losses from the incorrect registration of meters, and through the incorrect estimation of the amount of gas burned in the city lamps, and from many other causes; but I suppose that the first thing we would do, and certainly we should do it, would be to start out to find what was the absolute leakage, even taking into account the condensation and shrinkage—if we may use the term "shrinkage" to denote what Mr. Jones has covered in his paper, and "condensation" to cover the actual deposition of hydro-carbons in the main. Those two points can be determined. After that it remains to determine where the leakage is, and to stop it. It seems to me that if there is any fair amount of leakage, after we determine those points, it would pay us to go right back and put our money into a systematic investigation of the condition of the mains. I do not think we want to be misled. Mr. Sherman has pointed out that possibly the trouble may occur almost entirely through the meters. I do not think we want to deceive ourselves in that respect. There is no doubt that in some localities almost the entire trouble is due to that. I have in mind a case where we took hold of a certain works, and the leakage was simply outrageous. We investigated all the points that have been referred to, and came down to a place where we thought that we were simply

considering the leakage proper. We investigated the quality of gas sent out, the loss due to condensation, to shrinkage, etc., but there was one point that we did not cover at one particular station where there was an outlying holder. We did not investigate that ground, but afterwards found that there was some leakage there. In spite of all we did we still had a very large leakage; and although we went over all those mains foot by foot with drills, and stopped up every leak that we could find, we still had a very heavy leakage account. Therefore, I claim that we do not any of us want to comfort ourselves with the idea that we have not got any actual leakage account simply because our noses do not detect the leakage.

Mr. Young—I think that there ought to be a correct register kept of the temperature of the gas going into the station meter every day. I think in many cases, especially in small works, that the gas goes to the station meter at a very high temperature, and in that case the leakage would be very large. It is unaccounted-for gas. While it may not come under the head of leakage, it is due to shrinkage.

Mr. Scriver—I would like to ask the gentleman from Pittsburgh what cement joint he uses and what depth of cement is used—that is, what is the depth of the socket?

Mr. McElroy—Ours runs from 4½ to 5 inches. The socket of the 4-inch pipe is about 4 inches deep; you can make a very good joint on 3 inches, but we prefer 4 or 5 inches.

Mr. Scriver. Do you use any red lead?

Mr. McElroy—No.

Mr. Scriver—What is the depth below the surface of the ground?

Mr. McElroy—From three to four feet, according to circumstances.

Mr. Lansden—It seems to me that this question is always coming back to that of contraction and expansion. The real question is how to overcome it, and how to lay our pipes deep enough so that the temperature shall not affect any kind of joints, either cement or lead. I have tried both kinds. I have

taken up lead joints when I have found the lead drawn half an inch on each joint for three blocks. That was in the winter time. I have lifted those same joints in the summer time and found that they had crowded back. As my friend says, the cement joint is rigid, but your pipe has got to contract and expand. The question comes up, which is the best? The cement breaks your pipe, and the lead lets your pipe contract and expand. I should prefer to have the joints draw. Of course in a lead joint we depend a great deal on the packing that is put in—more in fact than we do on the lead or cement. I prefer that a joint should draw rather than have a pipe break in the winter time when it is hard to dig in the street.

MR. GILBERT—One word more on the subject which I alluded to when up before. This whole discussion shows that no matter what your joint may be, it is the action of the temperature and frost on the pipes that does the mischief. It is not essential whether the joint will draw, or whether the pipe will break, but what we want is to get the pipes so far down that the frost will not act upon them. That is the conclusion I have come to. Our friend from Pittsburgh says that he puts his pipes from 3 to 4 feet deep. Now I submit that those who live in a latitude north of this will not protect their pipes against the action of frost by putting them at that depth. It seems to me that that is the remedy for all the trouble—to spend a little more money in putting the pipes down a sufficient depth. There is another thing which should be considered, and that is the fact that wrought iron service pipes will in many soils corrode so that in 10 or 15 years there will be a leak. For the last few years I have made it a point to encase every service pipe in a wooden box with asphalt covering. Do this, and in ten years you will see the benefit of it.

MR. JONES—I must say that I have had the best results with mains laid in the frost—that is, with shallow mains. I have found from the Report of the Underground Temperature Committee of the British Association, that the point where a constant temperature is reached underground is 50 feet below the surface. Between that 50 feet below and the surface, there is a constant working going on, caused by the change of tempera-

ture of the soil; and anywhere in that 50 feet a lead joint will be affected more or less, so as to leak to a considerable extent. From each square centimetre of the earth's surface there issues every year 44.4° of heat. Now, if pipe is laid at a point underground, say three feet deep, and the frost is 3½ feet deep, this heat—the internal heat of the earth—is issuing through the surface and striving to bring about an equilibrium. If our overground temperature rises, it gives the underground temperature a chance to exert its force. Therefore, the frost comes out from the bottom, not from the top. The underground temperature—the internal heat—is what takes out our frost, and not the temperature from the top. As the frost lets go of that main an expansion takes place. Perhaps the next night it is relaxed; the overground temperature is lowered so that the frost is driven down and overcomes this underground temperature. The frost is lowered one foot, perhaps, and takes hold of the pipe again; and the working of the frost back and forth on the cast iron pipe is, I think, more the cause of breaking than the simple expansion and contraction caused by freezing and thawing. Therefore, I attribute the good luck I have had with shallow mains to the fact that they are in the frost all winter.

MR. PRICHARD—It seems to me that, taking the average temperature of the year as a factor for estimating the shrinkage of the gas, you very largely overestimate; because the selling temperature of the gas is rather the temperature of the cellar than of the earth, which my observation indicates to be very nearly 60°. It seems to me that if the temperature of the gas at the station meter is about 60°, we drop that factor from the calculation altogether. The temperature of cellars in our locality is certainly not down to 49°, and if we estimate our shrinkage as the difference between 60° and 49°, we overestimate it.

MR. ELLICE-CLARK—There are many thousand miles of cement joints laid in England, and I imagine that the average depths of those would be about 12 feet. I venture to say that there is not half a mile of water tight joints so laid in England. We find, either from the carelessness of the work-

men or from variations of temperature, or from some other difficulty, that it is impossible to get a water pipe tight with cement joints. For that reason at the present time in England cement joints are being generally abandoned; therefore, it is a matter of considerable engineering importance to know how a perfectly tight joint can be obtained in cement, and what is the practical way of accomplishing it, especially as cements vary so much. The cements of England are different from those of Germany. In Germany the cement manufacturers have adopted a standard as to the amount of free lime, as to tensile strength, weight, etc., but in England every engineer has his own specification; so much so that one cement manufacturer recently told me that he was working to 28 different specifications. I would like to know what rule is adopted in this country and how this joint is made so as to get it water tight. What standard of tensile strength is adopted for cement, and how it is put in place—whether in liquid shape or put in with a trowel?

Mr. Jones—I will endeavor to explain how we make our joints in South Boston. We find soft yarn, instead of old tarred ropes, better and cheaper in the end. We make a twist of the yarn, which requires to be driven in around the pipe with a caulking iron and hammer. After that yarn is driven home we take this mixture of common cement and sand and mix it thoroughly dry before we put any water with it. Then we thoroughly mix it with water until it obtains the consistency of mastic, so that it can be used on a trowel. That cement mixture is caulked into the joint with a wooden caulking tool until the joint is full, and until that cement has entered into and been driven into the yarn so that it becomes a part of it. Then, after filling that joint full of cement mixture, another twist of the yarn—the same size as the first—is entered and carefully driven home, not driven too much on one side at first, so as to drive out the cement from the other side of the joint, but it is carefully driven in alike at all parts of the pipe. After that yarn is driven we fill the joint again to the edge of the socket and clean it off and point it. As my foreman says, if the joint is not tight when that first yarn is driven and filled with cement it never will be tight.

On motion of Mr. Harbison the thanks of the Association were voted to Mr. Jones for his very able paper.

THE PRESIDENT—We will now take up Mr. Walton Clark's paper on fuel gas.

Mr. Walton Clark, Philadelphia, Pa., then read the following paper on

FUEL GAS.

Within the last few years there has developed a demand for a combustible, safe, cleanly and cheap; suitable for general distribution; applicable to the production of light and power, as well as of heat; ready for instant use; requiring no storage room upon the premises of the consumer, and brought without his aid to the point of combustion. To state the conditions of the demand is to prove a gaseous fuel necessary to its satisfaction, and I understand "Fuel Gas" in the meaning of the committee who selected me to open the subject at this meeting, to be such a gas or mixture of gases, luminous or otherwise, as is fitted to fulfill them. What I shall read to you is written with this understanding, which precludes the consideration of local plants for the manufacture of gas to be used on the premises. I confine myself, therefore, to the presentation of my ideas upon the subject of the manufacture and distribution of such gas as I believe will commend itself to our probable customers, and meet the reasonable expectations of profit which our employers may indulge, hoping to show rational ground for the faith that is in me.

A year and a half ago, I prepared a paper for the Western Association upon this subject. In it were given the ideas I then held, and now hold, as to the part of the demand for fuel we may hope to supply through pipes from central stations, and the mixture of gases which shall be at once suited to the public need and producible at a figure which shall not prohibit its sale. I now reiterate the opinion there expressed, that our operations as fuel venders will be confined to warming apartments, cooking, supplying light and power, and heating soldering irons, light forgings and other implements and materials demanding a small localized fire. That we can reasonably hope to supply

from our works fuel for boiler firing, metal working and other purposes demanding heat in great quantity, I do not believe. Such a gaseous fuel as will satisfactorily meet this demand, may be economically generated upon the premises where consumed, and will contain in its total bulk more of the original energy of the coal, than will a gas having sufficient heating power per cubic foot to be cheap to distribute and safe to use. Generated as wanted, it will carry to the point of combustion the sensible heat with which it left the producer, a further advantage over a generally distributed gas. It not being necessary to store this gas, distribute it over large areas, or supply it cold in small quantities, the presence of a considerable percentage of nitrogen is not fatal to its use, as in the case of the gas we are discussing. If I have not erred in this estimate of the field of fuel supply we can cover, the gas adapted to the wants of housekeepers, users of power, and, generally, consumers of fuel in comparatively small quantities, is the gas we must produce. What is this?

Among manufactured gases, not made wholly or in large part of oil, resin or other material very rich in hydrocarbons, coal gas is the ideal fuel for most purposes. With a high heating power per cubic foot, unmistakable odor and "tough" flame, it certainly answers the conditions of a successful fuel, unless we must except cheapness of production. Does it answer this condition also? It is said that in some favored localities, coal gas is being put into the holder at a cost that would enable the makers to sell to fuel users for a price lower per unit of energy than that at which a mixture of coal and other gases could be supplied, if its use were made general. Coal gas in the holder at a low figure, argues one or both of two conditions—low cost of soft coal, high price of coke. The cheapest gas will be made where both conditions exist; and this can only be where there is a demand for smokeless fuel, and a high selling price on anthracite. Were coal gas generally adopted as fuel in such a locality, the amount of coke put on the market would be increased at least five fold, and at the same time a considerable part of the demand for it would be met by gas. With its field in part taken from it, and its own quantity largely increased, the price of coke must fall until it reaches a point at which it

can compete with soft coal, for the purposes to which the latter is adapted. The amount thrown upon the market will force it from the position of a special fuel, commanding a higher price because it better meets the wants of certain consumers than does soft coal. I believe that with their present make of coke, few gas works do not at times accumulate a large stock. Multiply the make by five or ten, and can we doubt that the selling price must be very materially reduced to enable its owners to dispose of it? And if we take from the manufacturing account of the companies making this cheap gas the credit due to this most important residual, can coal gas then be generated at a figure justifying its sale at a price to compete with the cheap coals from which it is made? A careful consideration of the question, will, I think, convince us that we cannot afford in generating our gas to manufacture a by-product to compete with it in the fuel market.

I admit that there may be cities in which the demand for furnace coke for manufacturing would equal the supply after the general introduction of gas had increased the coke output. In such localities, if any exist, coke might advantageously be made in ovens, and the by-product, gas, purified and stored for distribution at a low cost. The few exceptions to the general rule do not, I think, affect the force of my argument.

As it is bad business policy to produce two commodities which shall compete with each other for a market, and as soft coal is the raw material suitable for conversion into gas, most plentifully and widely distributed over the world, we seem compelled to adopt, except in special localities, a method of manufacture that will convert this solid coal into a gaseous fuel, without the production of another substance applicable to the same purposes.

I look for no contradiction from any source when I say that unless there is in another course some object to be gained in the direction of more complete conservation of the energy of the raw material, or lower cost of production, which shall compensate for the attendant disadvantages, it is desirable that our product contain all the gas that may be distilled from the coal and resulting tar, with as much combustible gas as can be made from the coke, and nothing else. Such a mixture, if of

coal and water gases only, would have a heating power per cubic foot somewhat less than two-thirds that of coal gas, (400 U. about), a specific gravity of about .500, and its total heating power would equal somewhat over 60 per cent. of the original energy of the coal. In proportion as producer gas is made a constituent of the mixture, the heating power per cubic foot, and "toughness" and temperature of flame will diminish; the specific gravity, size of necessary holders, mains and meters, and the percentage of the energy of the coal in the total product, will rise. Thus, as we convert more of the coke from the distillation of the coal to producer gas, we correspondingly diminish the value of our product for each purpose to which it is applied, and increase the difficulties of distribution and utilization. The return we get for this impoverishment of our gas, and possible annoyance to our consumers, is an increase in the total energy derived from the coal. It is not safe to distribute a gas containing as much as 33 per cent. of producer gas, because of the danger of light-drafts extinguishing its flame. The additional energy we could put into the total bulk of the product of a ton of coal, by this admixture, is less than five per cent. To save this it would be necessary to increase the bulk of the gas, and, therefore, the size of storing and distributing apparatus very materially.

In the paper above referred to, I estimate the product of 2,000 lbs. of soft coal made into coal and water gas as 39,000 cubic feet, representing 54.5 per cent. of the energy of the coal; and converted into coal, water, and producer gases ($\frac{1}{3}$ of the coke going to the last) at 66,000 cubic feet, containing 57 per cent. of the energy of the coal. Here the gain through the generation of part producer gas is but 2.5 per cent. Later investigation leads me to the belief that my analyses of producer gas did not do it justice, and that the gain in energy resulting from its introduction to the product will be nearer 5 per cent. The increase in bulk is nearly 70 per cent. and the flame temperature is reduced over 400°. "It is principally upon this increase of bulk and reduction of flame temperature that I base my objection to the admixture of producer gas. We must provide storage room for a portion, and a very considerable portion, of our product. The amount, whatever relation it

bears to our daily output, will necessarily be increased in proportion to the amount of gas required to supply a given demand for heat. To supply this demand will require of the mixture containing producer gas, 60 per cent. more than of that containing only coal and water gases, and render necessary 60 per cent. more holder capacity. There is, of course, a pressure at which it will be found most advantageous to deliver this gas, and at that pressure the carrying capacity of our mains must be 60 per cent. greater for the more bulky mixture to deliver the same amount of heating power. This estimate makes no allowance for the difference in specific gravity, which would make the comparison still less favorable to the producer gas mixture."*

This mixture of the three gases would contain over 30 per cent. of nitrogen, have a heating power about 60 per cent. that of the combined coal and water gas, or 40 per cent. that of coal gas. It needs no argument to prove it a less valuable fuel per unit of energy contained, than the stronger compound, and I do not deem it necessary to reason further in defence of the claim that the richer in heating power per unit of bulk a fuel gas is, consistent with economy of production, the better our prospect of customers and profit. The considerations I have presented to you have led me to the conclusion that a mixture of coal and water gases, in the proportions which we can produce them from bituminous coal, meets the conditions of a successful undertaking better than any other possible combination, and have compelled me, in my efforts after a successful apparatus, to hold as a *sine qua non* the conservation of practically all the product of distillation, and the exclusion of nitrogen.

If I am correct in my conclusions anent the composition of a

*From previous paper by author. Since it was written the practicability of continuously distilling coal in retorts, with a portion of the waste heat from the generation of water gas (a problem I was then working upon), has been satisfactorily demonstrated, with a resulting economy in manufacture, and increase in production of commercial gas per ton of coal. This will explain why I now believe we can obtain better results than I then claimed possible. Further thought upon the utilization, or rather prevention, of tar, convinces me that it can be made to have a more considerable and beneficial effect upon the product than I then allowed for.

practicable fuel gas, I may now ask, and endeavor to answer the question, "What are the conditions that a perfect process must fulfill in its productions?"

1st. A portion of the combustible constituents of the coal must be burned to supply the heat absorbed in the generation of the gas. The remainder should be present in the product.

2d. The coal thus consumed should leave the apparatus as carbonic acid and steam.

3d. The sensible heat of the escaping gases should be utilized to pre-heat air or steam, and be so carried back into the apparatus.

4th. Radiation from the apparatus should be at a minimum.

5th. That part of the gaseous product of the coal having the highest heating power per unit of bulk should be present in the commercial gas.

6th. The raw coal should be subjected to the highest possible temperature, from the moment it enters the apparatus until the last distillable portion of the hydro-carbon gases and vapors has been driven from it.

7th. The tar made should be converted into gas, as far as possible before condensation, and as a means to this end, the water gas, hot from the producer, should be passed over the coal being distilled.

To my mind the above conditions can only be fulfilled in an apparatus providing for the distillation of the coal in a vessel isolating it from the gases generated in the combustion necessary to the supplying of the heat of gasification. Whether this vessel be of that form we are accustomed to call a retort, or not, whether horizontal, vertical or inclined, receiving coal by the shovelful or the ton, for the conservation of the coal gas made in it, its contents must be kept from contact with any gas not intended to become part of the commercial product. I am aware that insistence upon this point precludes the use of any simple cupola process for the manufacture of fuel gas for distribution.

To fulfill the conditions I have considered necessary to a perfect process, it is essential that the coal-containing vessel should be heated by the combustion around it, of a practically continuous stream of the otherwise waste gases of the process.

I am aware that insistence upon this point precludes the use of an independent fire for the coal distillation.

It is further necessary for the fulfillment of the conditions named, that the coal gas as made should be at once removed from the apparatus, and not brought in contact with any incandescent material other than the sides of the containing vessel. I am aware that insistence upon this point precludes the adoption of a plan involving the passage of the gas through masses of hot coke for its so-called fixing.

It is necessary to the generation of a product having the greatest heating power per cubic foot, consistent with conversion into gas of all the combustible constituents of the coal, that the waste or blast gases resulting from the combustion of that part of the coal supplying the heat of gasification, should be as poor in carbonic oxide as a proper regard for the conditions essential to the generation of a good quality of water gas (principally depth of fire) will permit, and contain almost no hydrogen. I am aware that insistence upon this point precludes the generation of a producer gas suitable to meet the fuel demands of manufacturers, as a step in the process of fuel gas making. In this connection I will at once admit, that, in a locality where a considerable amount of producer gas can be utilized so near the generator as to reach the point of consumption hot, and there is an opportunity, very limited in proportion, for the sale of fuel gas, it would perhaps pay to run one apparatus for the satisfaction of both demands. The admission of steam to the generator during the period of "blowing" preparatory to the water gas making, and the consequent reduction in the quantity of the latter, in proportion to the enrichment of the blast gases, makes in this process the distributable fuel gas little more than a by-product of the generation of producer gas, but if the sale of the fuel we are considering is destined to reach in its proportions the expectations of most men who have given thought to the matter, it is to my mind folly to consider any plan which has not for its object the conversion into a distributable gas of the greatest possible proportion of the energy of the coal. In a properly arranged and proportioned plant there will be work enough for the products of combustion from that part of the coal which

must be burned to supply the energy necessary to the conversion of the rest of it into gas. Due to our inability to make water gas or distill coal, except at high temperature, the carbonic acid resulting from the combustion referred to, will leave the apparatus, carrying much heat, and may be accompanied by a small proportion of carbonic oxide. The heat, sensible in each, and resulting from the combustion of the latter may be used to pre-heat the air necessary to the operation of the apparatus, and the steam used in generating water gas. Where mineral oil is cheap, the excess of heat in the blast gases can be utilized to distill a portion of it, with the desirable result of an increased heating power per cubic foot, of the product, and the further advantage of giving to the gas a serviceable illuminating power. Localities possessing both soft coal and mineral oil, each cheap, are favored beyond all others, as viewed by a "Fuel Gas Enthusiast." He could there hope to make an ideal gas cheap enough for use as a fuel, and so rich in hydro-carbons as to produce a satisfactory light at low cost without the aid of special appliances. Where there is no opportunity for the application of the waste heat to the distillation of oil, there is work for the greater part of it in connection with air and steam, as indicated above.

If 45 lbs. of coke is sufficient for the generation of 1,000 cubic feet of water gas in an apparatus built to fulfill, as far as the imperfections of workmanship and a proper regard for capital account will permit, the conditions I have given as in my mind essential to a perfect process, 2,000 lbs. of soft coal should yield, according to its quality, from 40 to 45 thousand cubic feet of gas, having a heating power of 375 to 400 units per cubic foot and representing 60 to 65 per cent. of the total energy of the coal. As arrangements for pre-heating the air used in the process were perfected, or other improvements reduced the consumption of coke per 1,000 cubic feet of water gas made, the product would be increased in total bulk and energy. This would result in a slight reduction in the heating power per cubic foot, because the water gas has a heating power below that of the commercial mixture.

Whatever process is adopted in the manufacture of fuel gas from soft coal, having for its aim the conversion of all the com-

bustible material to gas, either waste or commercial, a portion of the coal must be burned to supply the heat necessary to produce the change of form. I admit that this can be accomplished with less loss of heat through radiation, in a simple generator process than in an apparatus which the accomplishment of the end I aim at would demand, but in such simple cupola process there is of necessity a mixture of blasting with coal gas, involving a loss to the final product of the best part of the material, or a mixing with it of nitrogen or carbonic acid, or both. This fact is not affected by any ingenious application of exhausters, or the use of up, down, or alternating drafts. Such a process, comprehending this loss, is under obligation to show as an offset to these palpable defects some compensating economies or confess its own weakness. The disadvantages of an admixture of nitrogen are so serious that, between the horns of the dilemma, the operator of this process must choose to sacrifice some of the gases resulting from the coal distillation. This means serious loss, not only in the waste of gas, but in the consequent reduction of the heating power per cubic foot of the product.

There are many reasons why it is advantageous to the users of gaseous fuel to have it delivered to them at pressures considerably in excess of those usually prevailing in gas mains. It is not perhaps necessary to enumerate these. One only I will mention; that is the increased duty of lamps in which the illumination results from the incandescence of material woven into the form of a "mantle" or "cage." The increase in efficiency extends to both lamp and gas, and is the result of localizing the combustion by increasing the intimacy of the mixture of air and gas before reaching the burner tip. The "mantle" or "cage" under these circumstances is more highly heated, and therefore more brilliantly incandescent with a correspondingly increased duty; and the gas being more completely burned while within it, less of the resulting heat is wasted and the efficiency per cubic foot is increased.

The improved result is effected without any increase in the amount of gas used, or shortening of the life of the lamp. The total area of the gas inlets is reduced for the increased pressure and there is practically no more wear on the incan-

W. H. Price.

descent material. I mention this instance of the desirability of comparatively high delivering pressure because of my belief that lighting by incandescence is to be one of the potent causes of the success of fuel gas. That a most satisfactory result may be obtained with a non-luminous gas has been established. With the mixture of coal and water gases I have been considering, I believe we have in incandescent illumination a competitor of the electric light that has the advantage of it in color and price, and is less liable to the objection of heat than the open flames we now generally use.

The disadvantages of the use of high pressure are perfectly well known, and I believe as easily overcome. The increased tendency to leakage must be met by greater care in the laying and maintaining of conduits. The danger from breaks can be obviated by the use of automatic valves. Such pressure as it would be necessary to carry to satisfactorily supply all consumers, and enable them to operate at the maximum efficiency, such appliances as they would be apt to use in burning the gas for heat or light, would not at all imperil the integrity of the pipes or joints. Not more than 10 inches water pressure or less than ½ pound per square inch would answer all purposes. I have put miles of mains and services under an air and water pressure of over one hundred pounds without any effect beyond the discovery of rusted out services and defective joints. I do not think any one will question our ability to so lay cast iron, bell and spigot pipe, that the leakage account will not be excessive with 10 inches pressure. The advantages of high pressure are the greater range permitted the consumer in the utilization of the gas, and the larger carrying capacity of the mains. A pipe will deliver twice the amount of gas at 10 inch pressure as at 2½ inches. The fact that any leaks existing would be more readily detected and stopped, is an offset to the disadvantage of greater liability to leakage. Meters as made by first class manufacturers can be trusted to properly measure at 10 inches pressure.

In the paper already referred to, I gave the efficiency of gas cookers and heaters as varying from 32 per cent. to 77 per cent., quoting Mr. Travers of the British Gas Institute, as my authority. A long series of experiments made last winter, by

Mr. Carter H. Page, Jr., for the company which employs me, gives a lower efficiency for cookers. The work was done with stoves from eleven makers, each stove about the size generally known as 7B, and consuming between 30 and 40 cubic feet of gas per hour each.

The efficiency of the various burners was from 14 per cent. to 52 per cent., and the maximum (in which we are most interested as indicating the best result so far attained) was 55.4 per cent. The average of all burners of the eleven stoves was about 22 per cent., and of all burners of the best stove under specially favorable conditions about 38 per cent. It is only fair to the gas to state that no efforts were made in this series of tests to provide for the recovery of waste heat. The stoves were just as the makers put them on the market.

I am pleased, in view of the above figures, to be able to say that there is much room for improvement in gas stove construction.

In comparing the efficiency of fuels it is only fair to consider the work done with the best appliances obtainable. With the best stove at his command Mr. Page obtained an efficiency of 38 per cent. in an experimental test. Afterwards, in cooking meals for five persons, he found the efficiency reduced to 29.8 per cent. With a good coal range he obtained an efficiency of 3.36 per cent., starting, as with the gas stove, all cold, and cooking three meals a day. In each case care was exercised to prevent waste. In these tests the gas has the advantage of intermittent use, which it would lose in the case of heating stoves or furnaces kept alight night and day. In such work the advantage of gaseous fuel, though still very considerable, would be much reduced.

Discussion.

The President—Mr. Clark's paper is now open for discussion. As Mr. Loomis has had considerable experience with and has given considerable attention to this subject the Association would be glad to hear from him.

Mr. Loomis—I have carefully read this interesting paper on the subject of fuel gas, and there is a great deal in it that is un-

doubtedly of great use. Some of the things I will mention. The quality of the gas, which he proposes to distribute according to his scheme, makes it an ideal gas. It is a gas which we should all aim to make. It is practically a gas consisting of water gas and coal gas. It is all made from the same machine, and well mixed together without any admixture of producer gas at all. There seems to be the idea in some sections that I am in favor of mixing producer gas with water gas for street distribution. My idea is to build generators that will make a mixture that will answer for every purpose; that is, a mixture of gas for different uses. A machine must be made for making gas for manufacturers' use, for distributing it in the streets, and for doing different things—a machine that will make any kind of gas that is practically needed for the purposes that it is to be used for. In some metallurgical work and in some manufacturing establishments, a mixture of these gases is superior to either of the gases used alone—that is, a mixture of producer gas and water gas. In other uses the producer gas is superior for certain purposes. The flame temperature of water gas if mixed with it is too high. It makes a certain heat for some metallurgical works which we cannot use, and it has to be eliminated. What you are most interested in is the manufacture of gas, not for metallurgical works, but for general distribution in the streets. For all purposes, as I said before, the gas that Mr. Clark proposes to be made for that purpose is, according to my idea, as nearly a perfect gas as can be made. Perhaps the units of heat may be too large, that is, there may be too much of volatile matter in it to burn without having any Bunsen burner to give air. I think that all fuel gas should be burned in an open burner, because, as you know, it is impossible to burn these gases thoroughly in a Bunsen burner without varying the pressures, or varying the draughts of air. By mixing a large quantity of water gas with a certain amount of coal gas you get a high flame temperature which will burn in an open flame burner. In regard to the matter of pressure he is right. Practically the first works that I built were for metallurgical uses, at Turner's Falls, Mass. I built a holder with 16 inches pressure, and we can use it down to 10 inches. The next I built with 10 inches pressure, and we found that with that 10 inches for metallurgi-

cal purposes, better results were obtained than from either a higher or lower pressure. In some part of his paper, Mr. Clark says something with regard to producer gas, which it seems to me is based upon a mistaken idea with regard to its value or quality. Producer gas, if made with the style of blast furnaces or cupolas that are mostly in use is partially burned or destroyed in the making. That is, after they are made, air is carried up by the peculiar shape of the furnace, and the gas is partially burned while passing up the side of the furnace, and after it reaches the top the hydrogen is liable to be burned out of the gases, and they are reduced in quality, and contain not more than 60 or 80 units of heat, and sometimes as low as 50 units per foot. A producer gas made from soft coal should have about 120 to 130 units of heat. If the tar and all the heavy matter is made into fixed producer gas, then we have a gas which we can transport and burn at any distance from the generator with the sensible heat eliminated. The sensible heat is worth more to use for producing steam for running the apparatus than for any other purpose whatever. I am going to make a statement now that perhaps will bring up some discussion, and it is this: The sensible heat in gas we do not find of much advantage in furnaces, and it is better to utilize it by heating water, or by heating air to burn with it. If air is heated and mixed and put in the furnace good results are obtained. We made a number of tests with heating gas on waste products from a furnace, and on waste products from forges, and found that heating the gas up to 300° to 500° we got no practical reduction of the amount of gas consumed. In the same forge we treated the air in the same way, mixed with the gas, and we got a large percentage of saving. The reason that we get a larger percentage of saving in heating air, more than we do in heating gas, is because the air is expanded in the heating of it, and the gas mixes better with it and it is better ignited. Now, with regard to the sensible heat in producer gases. At a meeting of the Iron and Steel Institute of Great Britain, three weeks ago, this matter of gases was discussed thoroughly, and Mr. Head, an engineer in the employ of Sir Frederick Siemens, made a statement to the effect that they had made some experiments on that line, and had taken gases and cooled them purposely, after leaving the generator,

and burned them in a regular Siemens regenerative furnace; and that they got better results in this way than they did by taking the gas directly from the producer. He gave no reason for it; it was a mere statement of what he found out by experiment. There were a number of able engineers there at that time who expressed the same view. I am not making this as my own statement, but merely to show that producer gases have been cooled and can be cooled, and that they are not obliged to be used exactly at the place where they are made, but can be carried any distance, whether one mile or 100 miles. It is only a matter of the size of the pipe, and the gases can be used with great economy at various places. Works can be built and producer gas made and carried up into a town for heating, or carried to large works for metallurgical uses, or used for heating buildings or for any manufacturing purpose whatever. In making my producer gas I use no more of the coal than I use in any other process. I make as much water gas and coal gas mixed together as any process which is to-day running, or that is ready to be tested; that you can all see for yourselves. It is only a matter of investigation of the plants which I have built, and which are open to inspection by you at any time, and I will be glad to have you see them.

Mr. Denniston—I was asked by the Secretary if I could not prepare a paper on fuel gas, and I said I thought I would. At that time I expected to have the process in operation so that I could give you my experience, but I have been unfortunate in that, and have not had it in operation. I have, however, given some little attention to the subject, and have made some attempts at it. I certainly feel under obligation to Mr. Clark for the very clear statement that he has made, and I think that his paper is well worthy the careful consideration of gas men. I differ somewhat with our President, who this morning stated that he did not think that it was worth our while to attempt to make fuel gas. Possibly I misunderstood his language; but from hearing his address read I thought he stated that there had been so little success attending it so far, that it was hardly worth our while to attempt to make it. I hope I am wrong in this understanding, for I certainly think it is worth our while to make some investigation of this matter.

The President—I think if you will read what I said you will understand it differently.

Mr Denniston—Then I am wrong, and stand corrected. I would be thankful to any one who would make known any plan that will secure a good cheap fuel gas; and I am glad to see that Mr. Clark is so enthusiastic upon this subject. While he may not have got all in it that could be expected, and not all that he expected to get, still he is a little better than others who claim to have it all; and Mr. Clark deserves to have success if he has not attained it. I claim that even if he has not attained it he may yet attain success; and it may be a comparative success to him when under different circumstances it might not be a success to me or to other members in different localities, or under different circumstances. I think there is no question among practical men about the possibility of making, or even about the practicability of making, a fuel gas. The method of manufacture and the kind made, must determine largely both as to the cost and the utility of it. I have found in some recent experiences that an intense heat can be made from steam, oil and air, generated in an entirely different manner from this plan suggested by Mr. Clark. And that coal dust can also be used to advantage, where it can be obtained at low cost, and even that it may pay to crush nut coal and slack into dust in order to spray it into the retorts, or generators, as may be desirable, owing to what use it may be put to. Especially would this be the case if making only illuminating gas. The heat furnished during the trial I have referred to was such as to fuse the best fire brick in a short time, when properly applied. If not properly applied it would be of little or no value. This, however, is not singular to this particular gas, as the same may be said of any fuel gas, or indeed of any fuel; but it does not follow always that when the theory is correct the trial is satisfactory. Then, again, the practical man may succeed in the application of a principle that scientifically would be cast aside. How often have we seen labored and scholarly dissertations set at naught by some ingenious practical application, which, when seen, and it has become an accepted fact, can be easily explained, but of which it may have been asserted that

theoretically it was impracticable if not indeed impossible. Therefore, it is not for me or for any one, when Mr. Clark (who is qualified in a double sense), or any sensible man asserts he can accomplish certain results, to say it cannot be done, until after the fullest investigation and most careful trial it has been proved a failure. I have no doubt Mr. Clark can improve on present methods, and yet it may be a success to him now. There are certainly some things to commend in his plan. I believe that for certain purposes fuel gas can be made to take the place of solid fuel, and I believe it can be made from culm or coal dust, slack and oil, or oil and steam, or by a combination of these materials; and that hot air can also be used to advantage in the manufacture of the gases in the generators and retorts. Indeed, this is no longer a matter of belief—it is now knowledge; but I believe that for certain purposes and in certain localities it can be done with profit. It has been asserted that hot air costs, in energy to heat it, all it is worth in the heating furnace, but that depends upon circumstances; if you have the heat, and it is heat that would otherwise be lost, it would certainly be of advantage to use it where heat is required, and thus utilize a waste product; and then, too, may not the hot air, like the super-heated steam, be of value in aiding the formation of the gas, as well as its ultimate final combustion? I am an interested party in some new methods proposed, where this process will I hope soon be put to a practical test. Some experiments have been made—enough to show results heretofore unexpected; but a thorough test under favorable circumstances has not yet been made. Some time since a trial was made with a crude machine, where, as at Oliver Roberts' Pittsburgh wire mill, an intense heat was generated with a comparatively small amount of oil. It was there that this crude machine was operated for about a week, and was to a degree successful—so much so, indeed, that improvements have since been made, patents applied for and obtained, which it is claimed will, for iron and steel heating in reversible Siemens furnaces, prove a decided advance over present methods and produce a great heat at a comparatively small cost. Neither the plant to make it nor the gaseous fuel being expensive, it can be used as natural gas is used, with benefit to the iron or steel as the case may be. I do not claim that it can be made to su-

persede natural gas where it is, or in the immediate vicinity of natural gas districts; but that it can be used to advantage where coal is scarce and freights high and where oil can be transported in tank cars for less than either hard or soft coal. If an illuminating gas were wanted the same plant can be used, but only a minimum of air and steam would be used, and consequently a smaller production, which, too, would require purification. I have been pleased with the presentation of this subject by Mr. Clark, and I believe the subject will be kept before gas men and in fact all classes until we get a good gas fuel. It is hard for those of us who have been accustomed to gas fuel to contemplate a return, even in the dim distance, to solid fuel, with all its attendant dirt, smoke and general nuisance and filthiness. We want, in fact as well as in theory, a good, safe, fuel gas—and I was going to add "cheap"; but if in other respects it is satisfactory, a high price would be paid before we would again use coal. I hope and expect to learn more of this interesting subject.

I may say, before taking my seat, that I was somewhat surprised to see it stated in Mr. Clark's paper that he does not propose to discuss the fuel question upon anything but a coal basis; or upon the basis of fuel gas which can be distributed. My experiments so far have been for the purpose of attempting to get a fuel gas that could be used in iron and steel and such like furnaces, and not for general distribution. If we are successful in that, the other will follow. If you can get such a heat which was attained at the wire mill which I mentioned, and that can be proven to be successful, to such places as Pittsburgh, Chicago, and different manufacturing points, it would be of great benefit, though you might not get a fuel gas which could be distributed to the general public. As well might we undertake to distribute coal to every person throughout the West where wood is more plenty than coal. I think if we can get a manufacturing fuel gas, a fuel gas which can be used in the Siemens' furnace (as I claim this can be), that is a great point gained and these other uses will naturally follow. As to the amount of air necessary to be used, I may say that you can grade that to suit the character of the gas you want to make. And, as I have stated, if you want to make an illuminating gas,

you can leave out the air, and make it from oil alone, or by the combination I suggest. It is not made by cupolas, but by retorts; but not necessarily so, as it may be made in a cupola also. And further than this, to use culm, and the waste about coal mines is another object in view where you can make this gas from cheap fuel. I think Mr. Loomis stated in his remarks that while he used air of a certain percentage it not only carries the heat where you want it, but it aids in the combustion of the gas already formed; or if you have not got a fixed gas, to carry vapor into the furnace. It may do for that when it will not do for other purposes. For instance, it might not do for the manufacture of crockery ware, and such things as are glazed, for the steam would take the glazing off, whereas the same heat, made from the same products and put in a furnace for heating billets of iron or steel, would increase in amount the heat given off in that furnace. As I say I am not prepared with data which I expected to have, but hope to have them later.

The President—I think in the last six months, most of you have heard the statement made that progress is promoted by enthusiasts. We have a gentleman present, who is, I think, an enthusiast on this subject. I refer to our friend Faben. We shall be pleased to hear from him.

Mr. Faben—I did not come here to discuss fuel gas, but to listen. At some future time I may discuss with the gentlemen this subject, but I am not prepared to do so to-day.

Mr. A. C. Humphreys—I would like to ask Mr. Loomis what would be the maximum size of the outlet burner which he would use for the distribution of producer gas, and which would keep ignited under all conditions, so as to be perfectly safe. I have made some investigations in this line, and in every case where I have got on to the use of producer gas I found that the burner of the size which would ordinarily be used in a house was unsafe. In one case that possibly Mr. Loomis would be interested in, the burner was probably 2 inches in diameter, and it went out two or three times in the course of two minutes, and had to be lighted with a torch. I would also like to ask Mr. Loomis how, in the production of gas by the method which he has outlined or referred to, he would conserve all the

hydro-carbons of the coal? I cannot see how he could do so. The blast goes through the coal, and how he can chain the hydro-carbons to their places to let them free in the second part of the process, is somewhat of a mystery. I think it is due to Mr. Clark to point out that there has been no effort on his part to drag in a process, but rather to point out a theory upon which we must all work if we are going to be successful in the production of a gas for general distribution. Of course there would be exceptions. Mr. Clark has pointed that out very clearly, and perhaps the clearness with which these points are stated in his paper will be more apparent upon a second reading; but undoubtedly the point is well made that we must look to soft coal for our general heating gas. That is a fuel which is scattered all over the world, whereas anthracite is comparatively rare, and oil is comparatively rare—at least it will be comparatively rare when we come to use it in such immense quantities as we would have to for fuel gas. All these points have to be borne in mind.

Mr. Loomis—A question was asked with regard to a burner for producer gas. I did not say that I would distribute producer gas to be used for private consumption; on the contrary, I say that I would not.

Mr. Humphreys—I understood you to say that it could be done.

Mr. Loomis—I did not intend to say so. What I did intend to say was that producer gas could be carried in pipes to any distance and burned in metallurgical works, and for heating large spaces or areas where it could be burned in a large open fire. I said positively that I would not put any of it in with a mixture of other gases for street distribution, and that I would not distribute it for household use, because I know the liability of any gas to go out when it has air or nitrogen mixed with it.

Mr. Humphreys—Granting the position now taken by Mr. Loomis, will he not now answer my question: What would be the minimum size of the outlet of the burner?

Mr. Loomis—I cannot say what would be the minimum size.

It burns readily out of an inch or two inch pipe, but we have not had occasion to determine how small a burner we could use. We have burned it in a smaller burner, under blast. I said, to begin with, that I would not use the gas for household uses.

Mr. Humphreys—Leaving the houses out, I would like to get some satisfactory information as to the size of the burner. Do I understand Mr. Loomis to say that it would be safe for boiler purposes, or anything else, to distribute a producer gas and expect to burn it out of an inch and a quarter pipe?

Mr. Loomis—Yes, I think it would be.

Mr. Clark—Mr. Loomis speaks of the generation of producer and water gas, and the subsequent mixture of the two for some purposes. Do you mean, Mr. Loomis, the generation of producer and water gas in the same vessel, one process alternating with the other?

Mr. Loomis—Yes, sometimes we produce them at one time when the heat is in the right condition, in which case we mix them all together, or, we make them alternately, one in one place and another in another, and then mix them. In metallurgical works, we find they do not like to use water gas for many uses—I cannot explain to you all their theories—but they say that it has too high a flame temperature, or that they want a mixture of gases of lower flame temperature. Then we have another metallurgical works where, if we do not use a regenerative furnace, we are obliged to use higher temperatures, and to use water gas pretty nearly alone. At the Waltham Watch Works they were using illuminating gas to melt magnetic alloy, and it was impossible for them to do it under an hour and a half, and sometimes two hours; but with water gas alone they can melt it in thirty minutes.

Mr. Clark—You would not expect any difference between producer gas, as you call it, and the water gas made from the same apparatus, alternating, and a producer gas made with as much steam as the coal would take, would you?

Mr. Loomis—If you put the steam in and mix it all together you make a superior producer gas. Instead of being 60 per

cent. nitrogen, it will run down as low as 45 per cent. That makes a good producer gas, but it is practically part water gas. It has a large percentage of hydrogen. That gas can be worked for running gas engines, and is being so used in England largely at the present time, and has reduced the consumption of coal for gas engines down as low as one and a quarter pounds of coal per horse power per hour. That, of course, is a gas that will ignite in a gas engine.

MR. CLARK—I would like to get the composition of this gas which you say can be carried to a distance and used economically in metallurgical works. By "producer gas" in that sense, do you mean air gas?

MR. LOOMIS—That is an air gas. You may take nothing but air and pass it through soft coal and you can make a gas you can carry to any distance you like, and it does not condense or lose its vitality.

MR. CLARK—Will it then light cold?

MR. LOOMIS—Yes.

MR. CLARK—At Tacony, a few months ago, they told us the producer gas that was made from soft coal, in the endeavor to light cold was not a success—that they could make it burn as long as the torch was held to it, but when the torch was withdrawn it would go out.

MR. LOOMIS—Then it was blown out by the blast.

MR. CLARK—But it was what they call producer gas.

MR. LOOMIS—It would burn better at a distance. It would burn better over in the furnace house, 1,000 feet away, than it would in the generator house, and for this reason, when the generator starts and begins to make producer gas, there is a certain amount of steam left in the exhauster in the lower part of the furnace which has not yet passed through the coal at all, and that steam will go out with the first producer gas, and until it has a place to condense somewhere it will pass along with the gas and put it out. The gas they lighted for you might have been in that condition.

MR. CLARK—They told me that it was gas coming from a

producer holder, and I presumed, of course, that it was all right. At the Bethelem Iron Works there are a large number of Siemens generators lying idle, because they found it was not economical to carry that gas 1,500 feet to where they had to use it as producer gas. This statement was made by their assistant superintendent to me. That was not air gas; that was a gas that would probably have 50 per cent. more heating power per cubic foot. It was a gas made with steam.

MR. LOOMIS—But that has no more units of heat in it than the gas which I make.

MR. CLARK—Can you explain to me how it is that a gas that is made with air only, and which consists only of nitrogen and carbonic oxide, can have as high heating power as a gas which displaces a part of the nitrogen with hydrogen?

MR. LOOMIS—In the Siemens furnace very little of the steam goes into the gas. There is not as much hydrogen in their gas as there is in mine. In my gas I have from 10 to 12 per cent. hydrogen, without the admission of steam.

MR. CLARK—Where does the hydrogen come from?

MR. LOOMIS—It is there. That is all I know. Of course there is a certain dampness in the coal, and percentage of hydrogen in the coal.

MR. HUMPHREYS—I understood Mr. Loomis to say, a few minutes ago, that the gas was richer in the case of steam introduced into the blast, but I may have been mistaken as to that. I would like to ask Mr. Loomis if he cares to answer my inquiry in regard to how he preserves all the hydro-carbons of the coal in his process, when he sends gas through the coal?

MR. LOOMIS—I do not preserve all the hydro-carbons in the first two cases. We get the producer gas the same as you do. If you blast coke to incandescence, there is a certain amount of hydro-carbon in it in its first stage, and you do not get them all out. There is a certain amount of carbon that you must blow away before you can get incandescence. I don't know that I exactly understood what you wish to know.

MR. HUMPHREYS—What I am trying to draw out is this.

That it is not necessary to waste any of the hydro-carbon to get it ready for water gas manufacturing. What I was trying to draw out is either a denial or an acknowledgment that the gas ready for general distribution (which Mr. Loomis agrees will be the gas, which Mr. Clark has pointed out as being an ideal gas) could not be produced from his apparatus and retain its hydro-carbons.

Mr. Loomis—Do you think that none of them can be retained?

Mr. Humphreys—I do not say that, but can they all be retained?

Mr. Loomis—No, I do not retain all the hydro-carbons, but I accomplish the same thing, as the heat units are saved in one way or another.

Mr. Humphreys—My question refers to the commercial gas as made ready for distribution.

Mr. Loomis—No, I do not retain them all, nor does any one else, by any process.

Mr. Clark—I have not spoken of any particular apparatus, and I want to ask you if the steps of the process which I have described in this paper will not result in a concentration of the coal gas in the final product?

Mr. Loomis—I cannot say as to that, but I think you will find difficulties such as you have not yet encountered in working them out.

On motion of Mr. Rowland a vote of thanks was passed to Mr. Clark for his paper.

Committee on Place for Holding Next Meeting.

On motion of Mr. Harbison the Chair appointed the following gentlemen to serve as a Committee to designate the place in which to hold the next annual meeting: A. E. Boardman, Macon, Ga.; Thomas Turner, Charleston, S. C.; E. G. Cowdery, Milwaukee, Wis.; G. S. Hookey, Augusta, Ga., and J. P. Harbison, Hartford, Conn.

Introducing Commissioner Barker.

The President—We have with us to-day Mr. Barker, a member of the Massachusetts Board of Gas and Electric Light Commissioners, and I invite him to a seat on the platform. We know that he is always willing to give us a word of advice and encouragement. (Applause.)

Mr. Barker—Mr. President and Gentlemen of the Association: I regret to say, Mr. President, that I did not hear the whole of your remarks. I happened to be busy talking with a gentleman when you began speaking, when I heard my name mentioned and something said about the platform. I hardly think you would care to have me take the time of the Association which might be better spent in listening to others. I must thank you, however, for the very pleasant way in which you have mentioned my name, and for the very pleasant way in which the allusion to the Board has been received. It is but one of a long series of courtesies which the members of this Association, and of some of the other Associations in the country, have been pleased to extend to me as the representative of the Board. I am very glad indeed to be able to express the cordial gratification of the Board for very many acts of kindness. It has been my good fortune to visit a large number of the companies throughout the country, and I confess that I have been somewhat surprised, as well as very greatly gratified, at the cordial reception which, as a representative of the Board, has been given to me. The confidence which has been shown by the exhibition which representatives of companies have made to us of their work, and of the facts coming to their knowledge—a confidence which, I am happy to say, has never yet been betrayed—has been of very great service not only to the Board, but I trust of considerable benefit to the companies with which the Board sustains such intimate and important relations. As I have said, Mr. President, I do not think that it is wise for me to take the time of the Association which can be better spent in listening to these very interesting papers which have been prepared. I can only express to the members of the Association my profound wish for their prosperity and their success in

the solution of the very important problems to which their attention is directed. (Applause.)

Mr. Harbison—Although a vote of thanks has been given to Mr. Clark for his paper, I think that we ought not to let the matter drop here. I am quite interested personally and officially in the subject of fuel gas. I do not want a gas which can be used in iron works specially, or only in manufacturing establishments, but I want one which can be distributed for general use by the public, so that the Company which I represent can enter into the business of producing it and make an honest dollar by selling it at a reasonable price. I believe that Mr. Clark has started in the right road, and that he is working in a direction which will tend to the realization of our hopes. Others may be, and no doubt are, working in the same field. We shall hope that they will arrive at practical results and not simply at theoretical results. I do not care to know especially whether a producer gas can be carried 50 feet or 100 miles from the point of production. The question is, will it pay to do it? Can it be carried in connection with legitimate fuel gas or water gas? If not, then what advantage is it to us to discuss the question or to waste any time in discussing whether fuel gas can be carried that distance. Of course there can enough of it be made to be of practical value to a company engaged in the business of making and selling fuel gas. I move that Mr. Clark be requested specially by the vote of this Association to present to us, at our next annual meeting, the results obtained in his investigations during next year. I make this motion because I think the subject is one of great importance to the members of this Association, and because it is desirable to have practical results presented to us. I know that Mr. Clark, like many other members of the Association, is extremely modest and bashful, and might not be willing, without some request on our part, to come before us every year with a paper on this subject; but I think that he is eminently fitted to prepare such a paper, and I hope he may be requested by the vote of the Association to do so, and present it to us next year. I so move.

The motion prevailed.

Mr. Clark—I appreciate the kindness of Mr. Harbison's

remarks. I cannot promise that I will tell next year what has been done with the apparatus that I am at present operating, but if I am successful you will certainly hear from me.

THE PRESIDENT—We will now listen to the paper by Mr. B. E. Chollar, of Topeka, Kan., on the

PURIFICATION OF GAS FROM KANSAS COALS.

The gas coal fields of Kansas at the present time are limited to a small district, hardly more than 20 miles long and 5 miles wide, situated in the counties of Cherokee and Crawford, in the extreme southeastern part of the State. The coal deposit is three to four feet in thickness, and is found at the depth of about 40 feet below the surface of the ground. The vein is not continuous, but considerably broken up by clay seams, commonly known as "horse-backs." The appearance of the coal at first glance is much the same as that of the product of the Eastern mines, excepting perhaps that the color might seem to incline to a brown or a dark bronze. It is softer and more friable than many of the Eastern coals, and is especially liable to disintegration from exposure to the weather. The coals as shipped from the mines, contain large quantities of iron pyrites; not only in well defined streaks, but also thoroughly permeating the whole mass. About six per cent. in weight of the coal can easily be picked out for rejection. The coal is a fairly good gas and coke producer; the average yield at Topeka for two years being 4.56 feet per pound, and the average illuminating power 17.42 candles. The coal furnishes about two-thirds its weight in coke heavily charged with sulphur, but of good heating power. The quantity of ash and clinker is fully one-eighth the weight of the coke. The composition of gas in respect to the two principal impurities, is subject to very great and very rapid fluctuations. Contrary to the usual rule, the sulphureted hydrogen is far in excess of the carbonic acid; the former varying in quantity between 40 and 75, and the latter between 15 and 25 volumes per thousand. Two examinations in quick succession of the gas just before the condenser gave, respectively, 59 and 60 volumes per thousand of H_2S, to 14 and 14 of CO_2. At the same time, the gas immediately after the condenser indicated 55 volumes

of H_2S and 14 of CO_2 per thousand. The general effect of the condenser is to remove sulphureted hydrogen and not carbonic acid.

In the purification of gas from these coals, the popular idea that CO_2 combines more readily than H_2S with lime, is contradicted, and the opinion is confirmed that such a theory could not have gained credence where coals similar to these were used.

The experiments next following will show the condition of the several purifiers, when the gas at the outlet of the third was about to show a foul test with lead paper.

	H_2S Vols. per 1000.	CO_2 Vols. per 1000.
Outlet 3d purifier	nil	3
" 2d "	10	5
" 1st "	50	10
Crude gas	48	15

The first purifier was doing good work with respect to CO_2, but was discharging into the second more H_2S than it was receiving at its own inlet. The load, it will be noticed, was chiefly on the second, which was removing 40 volumes, or fully four-fifths of the H_2S, and at the same time a quantity of CO_2 equal to that absorbed by the first one. The third purifier was removing the last fifth of the H_2S, which, under ordinary conditions, it could easily do with the presence of so small a quantity of CO_2.

The quantity of carbonic acid indicated above at the outlet of the third purifier is probably over estimated, by reason both of the difficulty of accurately measuring so small a contraction as three volumes in a thousand, and of the fact that nearly the same error of estimation is included in this small quantity as might be expected in a larger one.

What little CO_2 there was left in the gas, was probably all, or very nearly all in combination with NH_3; the gas at this point was alkaline, and required a strong flow for 15 to 20 minutes to produce a visible effect upon a solution of acetate of lead.

On the same day, after putting a fresh purifier to work, a similar examination resulted as follows :

	H_2S Vols. per 1000.	CO_2 Vols. per 1000.
Outlet 3d purifier	0	3
" 2d "	8	4
" 1st "	12	6
Crude gas	44	16

The purifier that was second in the previous case had now become first in the series, and it was still able to remove 32 volumes of H_2S and 10 of CO_2.

After about 200 M of gas had passed, the following result was obtained.

	H_2S Vols. per 1000.	CO_2 Vols. per 1000.
Crude gas at start	52	12
Outlet 2d purifier	8	4
" 1st "	26	6
Crude gas at end	51	13

The first purifier was perceptibly weakening, but still was able to remove 25 volumes of H_2S and 7 of CO_2. The second remained about in the same condition as before. The test at the outlet of the third was omitted.

Several hours before the next change of purifiers the condition was the following:

	H_2S Vols. per 1000.	CO_2 Vols. per 1000.
Outlet 2d purifier	8	4
" 1st "	40	6
Crude gas	50	16

The first purifier had nearly lost its grip on the H_2S and allowed 40 out of 50 volumes of H_2S to pass into the second. It was, however, able to stop 10 volumes or two-thirds of the CO_2. The foregoing experiments go to show beyond a doubt that not only does the lime take up the H_2S more readily than it does the CO_2, but also that a lime purifier when saturated with H_2S may still continue to take up CO_2.

In order further to test this matter, the crude gas was passed in a wash bottle through the several solutions enumerated below.

	H_2S Vols. per 1000.	CO_2 Vols. per 1000.
Crude gas at start	51	15
After carbonate of ammonia	37	33
" " " soda	7	19
" milk of lime	3	15
" caustic soda	3	14
Crude gas at end	50	14

The caustic alkalies removed nearly all of the H_2S, while they hardly touched the CO_2; while on the other hand, the alkaline carbonates actually increased the quantity of CO_2. This latter action is confirmed by the action of the washer, which, when the flow of water becomes partially stopped, not unfrequently does the same thing.

It would seem, therefore, that notwithstanding the greater affinity of the lime for the H_2S than for the CO_2, yet in consequence of the great abundance of the lime in operation, the actual absorption of both of these impurities is proportional to their relative quantities present in the gas. In the above experiments, the estimation of ammonia has been neglected.

In order, however, to find out if any perceptible error had been made by so doing, the crude gas was passed through diluted sulphuric acid, determinations of the H_2S and CO_2 being made before and after as follows:

	H_2S Vols. per 1000.	CO_2 Vols. per 1000.
Crude gas	42	19
After acid	41	21
Crude gas	41	22
After acid	42	22

One of two things is probably true, *i. e.*, either the quantity of NH_3 was too small to measure by volume, or it was in the form of carbonate, which, upon being decomposed by the acid, set free its own volume or thereabouts of CO_2. In either case the volume of ammonia present was quite probably not in sufficient quantity to affect the relative proportions of the other impurities as determined above.

In examining the hydraulic main liquor from the Kansas

coals, two noticeable characteristics will be observed—instead of finding the ammonia chiefly in the form of carbonate, as is usually the case, we find it almost entirely in the form of chloride. So free from carbonates is it usually found that only at times will the addition of strong acid produce any effervescence. It weighs about 6° Twaddel, and indicates about 9 oz. strength per U. S. gallon by distillation.

The liquor from the condenser is very highly charged with carbonates as well as with sulphides. It effervesces furiously on the addition of an acid, and gives a strong precipitate with acid sulphate of iron. It weighs about $4\frac{1}{2}$° Twaddel, and indicates about $5\frac{7}{10}$ oz. strength by distillation. The water from the washer contains chiefly the sulphides of ammonium, with a fair share of carbonates. It weighs ordinarily only about $1\frac{1}{2}$° Twaddel, but indicates about 5 oz. strength by distillation.

The removal of so large a quantity of H_2S in the purifiers produces as a matter of course a corresponding quantity of water, which drains through the lime and collects on the bottoms of purifiers. This water weighs about $3\frac{1}{2}$ ounces and indicates about the same number of ounces in strength. It consists chiefly of the sulphides of ammonium and of calcium. Notwithstanding the large quantity of sulphur compounds in this gas, the practical purification of it is not so difficult a matter as one might reasonably expect. The purification is conducted entirely with reference to the H_2S; the CO_2 will cause no trouble. Effective condensation will remove the tar and help to a certain extent with the H_2S. Thorough washing or scrubbing, especially the latter, will remove no small quantity of the soluble sulphides. In the purifiers the quantity of H_2S being so extremely large, the lime is rapidly converted into sulphides, thus providing an ample supply of material for the absorption of the sulphides of carbon—these latter compounds are well represented in the crude gas, so well in fact, that in case the purifiers fail to act properly, they have a way of showing their presence at the burner as much to the disgust of the consumer as to the annoyance of the producer.

In working the purifiers, it is best not to trust too confidently the indications of lead paper, especially at the outlet of the third box; for by the time the foul test is shown at that

place, the first purifier will probably have become over-charged with H_2S, and the middle one uncertain in condition, thus throwing too great a responsibility, as it were, upon the last box. The sulphides of carbon, as is well known, give no warning of their coming, and are liable to appear at any time after the first purifier has become inactive.

A safe way to operate, particularly in winter, is by a kind of "rule of thumb;" that is to say—find out by experience how much gas can safely be passed per purifier, then to be careful not to exceed that quantity, being, however, always ready to make a change at any time, in case a foul test should appear.

The proper preparation of the lime, as well as the filling of the boxes, are matters of especial importance and should receive careful attention. With purifiers of sufficient capacity, two trays of lime, each one foot deep, in each purifier, has been found to give good satisfaction. The average duty of the native lime is between 5,000 and 6,000 feet per bushel.

In view of the foregoing, it will hardly be denied that the successful purification of this gas demands an alkaline material. Lime is effective, but costly. Fortunately, however, ammonia abounds in good quantity in the gas, and it is not improbable that at a day not far distant the substitution of this compound for lime, together with converting the H_2S into sulphuric acid, will remove this last named source of expense and overcome the greatest objection to the use of these coals.

The peculiar affinity of ammonia for H_2S is well known, as also is the extreme solubility of the sulphides of ammonia.

Estimating the average quantity of H_2S in the crude gas at 50 volumes per thousand, the weight of pure sulphur will be more than 40 pounds—a quantity sufficient to produce more than 100 lbs. of sulphuric acid—in the gas from each ton of 2,000 lbs. of coal.

The present cost for lime is nearly three cents per thousand feet. If the cost of operating the ammonia purification should be no greater, the sale of sulphuric acid and of sulphate would have the very satisfactory effect of changing a heavy expense into a handsome profit.

Discussion.

MR. EGNER—I would like to ask Mr. Chollar what is the condition of the lime? Is it very wet?

MR. CHOLLAR—It is wet, but not so wet as is customary to use it where Pittsburgh and Eastern coals are used, because the Kansas coals have a larger amount of sulphureted hydrogen which generates water in the purifiers.

On motion of Capt. White, the thanks of the Association were voted to Mr. Chollar for his interesting paper.

THE PRESIDENT—We will take up one more paper to-night, which will still leave five for to-morrow.

Mr. Jno. Young, of Allegheny, Pa., then read the following paper on

SOME THOUGHTS ON FUEL GAS INDUCED FROM PRACTICAL EXPERIENCE IN THE DISTRIBUTION OF NATURAL GAS.

Mr. President and Gentlemen of the American Gas Light Association: The discovery and application of natural gas for domestic heating, and manufacturing purposes in quite a number of places, and its superiority over coal as a fuel, have stimulated research into the possibility of manufacturing a fuel gas to supply localities not favored with the natural article. Some of our ablest and most advanced gas engineers have taken the matter in hand and have, in these meetings and elsewhere, expressed their faith in the ultimate commercial success of a manufactured fuel gas. That there are at present, however, very great difficulties in the way, will, I think, be admitted by the most sanguine. The most formidable difficulty that has to be encountered is in what I may term the commercial difficulty, viz.: The difficulty of producing the gas at a price people will buy it. There are other difficulties which our experience in supply of natural gas has made very evident to us, and it is probable they may have been overlooked to some extent by those having no experience in supplying fuel gas. I refer particularly to the erratic and varying demand and to the

great disproportion between the maximum and minimum demand. These may be termed simply mechanical difficulties but to overcome them will greatly increase the commercial difficulty as it involves excessive outlay on plant. In order to make this matter as clear to you as possible, I shall deal with the whole of our domestic consumption in Allegheny City.

Allegheny City is supposed to contain a population of from 90,000 to 100,000. The number of houses is probably about 15,000. Of that number we supply 7,500. We consider we supply almost every house worth supplying and probably in the cities of the size and character of Pittsburgh and Allegheny not more than one-half the houses would use fuel gas, even if its cost approached the price of coal. There are various reasons for this which your experience in supplying illuminating gas would suggest. Taking, then, the city of Allegheny, with its 100,000 population, as an illustration of the quantity of fuel gas required for a given population, we can learn something of the capacity of a fuel gas plant required for its supply from our experience in supplying natural gas.

We can arrive at this pretty correctly from the fact that about one-half of our consumers are supplied by meter. There is, therefore, no haphazard estimate as to the quantity of gas required. Last winter was exceptionally mild, and the figures would give the minimum rather than the maximum of winter consumption. The average consumption per house per day from November 1st to April 1st was 2,000 cubic feet, but as at least 75 per cent. of that quantity is used between the hours of 7 A. M. and 10 P. M., it would be necessary to provide for an average consumption of 100 feet per hour for each house, or at the rate of 750,000 feet per hour, making for the 15 hours a total of 11,250,000 cubic feet. Add to this the additional 500 cubic feet required for each house for the balance of the 24 hours, and we get a total of 18,000,000 cubic feet as the quantity necessary to supply 7,500 consumers on an average winter day.

You will notice, however, that for nine hours out of the 24 the consumption is only 500 feet per hour for each house, equal to a total of 416,666 cubic feet per hour, as against 750,000 for the other 15 hours, the average for the 24 hours being 625,000 feet per hour.

I need not point out to you that to produce gas economically it is necessary the production should be pretty nearly uniform during the 24 hours. To make 750,000 feet per hour for 15 hours and then drop to 416,666 for the remaining 9 hours would be very awkward and also very costly. It will, therefore, be necessary, in order to get a uniform production, to have a storage capacity of 3,750,000 cubic feet. There is, however, another and more difficult phase of the matter. In providing for the supply of fuel gas to any community it will be necessary to provide manufacturing and distributing plant adequate to supply the greatest consumption. The greatest consumption will, of course, occur on the coldest days. As the temperature rises or falls, so in a regular proportion will the consumption be greater or less. With a given consumption at 32° temperature, it will increase 50 to 60 per cent. if the temperature falls to zero. In our changeable climate, such a fall often occurs within 24 hours. Within that period the consumption may rise from 750,000 feet per hour to 1,125,000 feet per hour, requiring 16,875,000 feet in the 15 hours, instead of 11,250,000 cubic feet, an increase of 5,625,000 in 15 hours. You can appreciate the difficulty of being suddenly called upon to increase your production by over 5,500,000 feet. Therefore, to avoid intermittent work and provide against failure of supply, it will be necessary in order to supply even the comparatively small number of 7,500 consumers to have an enormous storage capacity. In the demand for illuminating gas, there is a gradual and steady increase from the minimum to the maximum consumption, and a corresponding steady decrease from the maximum to the minimum. On the contrary, during seven months in the year, the demand for fuel gas is most erratic, sometimes varying from 50 to 60 per cent. in 24 hours, and seldom for a week together will the demand be anything near uniform. In June, July, August and September, the consumption of fuel gas dwindles down to a mere fraction of the winter consumption. The difficulties that have to be met in erecting a fuel gas plant are, first: The necessity of providing a manufacturing and distributing plant equal to the greatest demand (which demand may only exist for two or three weeks in the year), involving great outlay and comparatively small returns. The providing for erratic demand necessitating great

[illegible] intermittent and expensive working. It [illegible] I try and give you an idea of the [illegible] of a fuel gas plant necessary to supply 7,500 [illegible] assume the possibility of distilling the vol- [illegible] coal and converting the residual [illegible] water gas at [illegible] operation in the same vessel. I shall [illegible] produce 30,000 feet per ton of coal [illegible] giving 400 heat units per cubic foot. I shall [illegible] considerable of an assumption) that by [illegible] for using the gas, one foot of the fuel gas [illegible] per foot can be made to perform the [illegible] that one foot of natural gas is now doing with [illegible] heat units per foot.

I shall further assume that coal will cost $2.00 per ton and that each stoker (I do not know any better term) will produce 75,000 feet per day. To get at the maximum quantity required, it will be necessary to get the average temperature for the five months on which our figures are based, then allow for the extra quantity required at a zero temperature. The average temperature for the five months was 36.64 degrees, and, as the average daily consumption of gas was 15,000,000, we must add at least 50 per cent. to that quantity, making 22,500,000, the maximum daily quantity that must be provided for. The yearly capacity of a plant providing 22,500,000 feet per day is 8,212,500,000 feet, but as during (we shall say) seven months of the year the average daily consumption is only 15,000,000 cubic feet, and during the other five months only one-fifth of that quantity, the total amount required for the year is only 3,639,000,000, equal to only 44 per cent. of the actual producing capacity of the plant. I am not sufficiently conversant with the cost of fuel gas plants to give a very correct estimate of the cost of a plant capable of producing and distributing 22,500,000 cubic feet per day, but if I place it at $3,000,000 I think I shall rather under-estimate than over estimate it. With these data we shall try and [illegible] what figure fuel gas can be produced.

[illegible]	....$242,000, or, 0.06660 cents per M.
[illegible]	[illegible], or, 0.02660 " "
[illegible]	[illegible], or, 0.00549 " "

Distribution, repairs and maintenance (streets)	26,000, or,	0.00714 cents per M.
Wear and tear and yard expenses..........	36,390, or,	0.01000 " "
8 per cent. on $3,000,000................	240,000, or,	0.06595 " "
		18.178 cents per M.

It will be seen that in providing for the wants of even a comparatively small community, we have to deal with large quantities, and if the use of a fuel gas were to become anything like general in our large cities, the consumption of raw material would be enormous. At this point it is pertinent to inquire what material can be had in sufficient quantity to supply such a large demand, and I think we can reply unhesitatingly, coal, and coal only. It is also safe to make the assertion that the whole of the coal must be converted into the gaseous form. If the volatile portion of the coal alone were used, no sufficient market could be found for the immense amounts of secondary products, such as coke, tar, ammoniacal liquid, etc. While petroleum may be a factor in the production of fuel gas, so far as my knowledge extends, its quantity is too limited to be depended upon as a universal fuel.

You will observe there is nothing included for purification or leakage.

The gas produced from the volatile portion of the coal should contain about the usual percentage of ammonia. If that is extracted, manufactured, and sold, I assume it would pay for the purification. I have taken the cost of coal at $2.00 per ton, as I presume that is about an average price. Of course, any advance or decrease from that price will proportionately affect the cost of the gas. If the above figures are anything near correct, they indicate that a fuel gas containing 400 heat units per foot can be produced and sold at 20 cents per M cubic feet, when the quantity produced is large. The problem to be solved is, can this gas be made to perform the work of heating and cooking in a house at a cost not to exceed 25 per cent. more than the cost of coal. I believe it must do this in order to become a popular fuel. One ton of coal will develop 27,000,000 heat units. 30,000 cubic feet of gas at 400 heat units per foot will develop 12,000,000 heat units. By perfect combustion, and

greater utilization of the developed heat, it may be possible to make 30,000 cubic feet of gas perform the work of a ton of coal, but even then the 30,000 feet will equal coal at $6.00 per ton.

You will bear in mind that the estimate I have made of the quantity of gas to be produced is based on the supposition that 1,000 feet of fuel gas of 400 heat units per foot will perform the same amount of work we are now doing with natural gas having 1,000 heat units per foot.

Notwithstanding the great progress that has been made during the last fifty years in attaining in practice to theoretical values, it seems as if very little progress has been made in utilizing to anything near its theoretical value the fuel used in private residences. The abundance and cheapness of wood and coal have caused the matter to be left almost untouched, and to-day the appliances for heating our houses, so far as the principles of economy are concerned, are about as unscientific and wasteful as they were a hundred years ago. If fuel gas is to be the fuel of the future, attention must be turned to devising means, first, to secure perfect combustion of the fuel, and then to utilize the developed heat to the utmost extent for heating the inside of our houses, where it is wanted, instead of sending from 80 per cent. to 90 per cent. of the heat up the chimney to heat the atmosphere outside where it is not wanted. In this direction I think lies the solution of the fuel gas problem. The price at which a fuel gas of practical value can be manufactured and sold is pretty well determined, and under no circumstances, so far as I can see, can it be sold cheap enough to displace coal if used in our present appliances. That it is possible to greatly improve on our present methods and attain much nearer the theoretical value of the fuel, admits of very little doubt, but as yet comparatively little has been done in that direction. We still adhere to our various forms of stoves and open fireplaces, hot air furnaces that do not heat the air, unless the products of combustion are going into the chimney red hot, and steam heaters that are even worse in this respect. There is no difficulty in constructing a hot air furnace in which the products of combustion can be reduced to the temperature of the outside atmosphere, if it is desired to do so, thus utilizing the greatest

possible amount of heat generated by the fuel. In heating by steam or hot water this of course is not practicable, as the products of combustion must pass into the chimney at a higher temperature than the water or steam, and thus lose a great deal of heat. It might, however, be possible to utilize the waste heat in some way, say by combining the steam heating with a hot air furnace. The rapid progress that has been made during the last few years in reducing the cost of production and distribution of electric lighting, its rapidly growing popularity for street lighting and for stores, hotels, theatres, railway stations, and even private residences, point to a not far distant time when illuminating gas companies must look to some other means of utilizing their manufacturing and distributing plant than in the supply of illuminating gas. Would it not be well for gas companies to spend some time and money in investigating into the possibilities of a manufactured fuel gas when applied to domestic heating and cooking on thoroughly economic and scientific principles. To carry out an investigation of this kind thoroughly will require a thorough knowledge of the laws of combustion, a knowledge of the best methods and appliances for utilizing to the utmost possible extent the heat produced, and a knowledge of sanitary laws that will prevent securing economy at the expense of proper ventilation, and the healthful conditions that should obtain in every house. A good deal of isolated effort has been already made in this direction, but so far as I know, very little of a reliable character is yet known which embraces all the above conditions. To existing gas companies will naturally fall the supplying of a fuel gas, if such a thing is practicable, and surely it is worth while to try and find out with some degree of certainty what can be accomplished in that direction. If the public demand a fuel gas, there is hardly a doubt but the demand will be met, no matter how great the difficulties in the way may be. The importance of pure air in relation to health was never realized to the extent it is to-day. There is a general outcry against the filthy, unhealthy, costly and unscientific system of throwing into the atmosphere of our cities thousands of tons of unconsumed carbon in the form of smoke which depresses our spirits, irritates our lungs, saps the energy of our wives and daughters by the incessant and irritat-

ing warfare against dirt, and lowers the whole tone of our moral and physical nature. The remedy is gaseous fuel. It may be difficult and somewhat costly, but if it falls within the range of possibility, there is little doubt of its accomplishment.

Discussion.

THE PRESIDENT—This is a very interesting paper, indeed, and raises questions worthy of consideration and discussion.

MR. DENNISTON—Without having known what Mr. Young was going to say, I am happy to have him corroborate my statement that it would be a difficult matter to manufacture fuel gas for general distribution, or for cities generally. If I accomplish what I aim to accomplish in furnishing a fuel gas for iron and steel furnaces, very much will be accomplished towards the end desired. You will see, by Mr. Young's paper, the immense amount of holder capacity that we must have to supply a producer gas that could be distributed at anything like the figure given. Mr. Harbison says he does not want anything of that kind, but I will be satisfied if I can get such a gas as I claim it would be an advantage to us to try to get, and for the members of this Association theoretically and practically to work for. If you can get enough to run one iron furnace successfully, without a holder even, you have accomplished a great deal. But you will not need such a great holder capacity for such purpose. There will be no more holder capacity required than for the ordinary gas supplied to-day. What do the gentlemen want? Do they prefer to go to individuals? Would they sell lower to manufacturers than they would to a thousand individuals that they might distribute the gas to? You get one mill fully supplied with a good, cheap gas, which will take as much as a thousand individuals, and you have accomplished a feat which will make you a hero. Now, I ask you, as practical men, whether or not that thing can be done? What I want to say is that I do not believe it can be done on the scale marked out by Mr. Young, for that amount of money; that I do not believe you can get holder capacity enough in this city, with its eight gas holders, to supply the necessary fuel gas for all the people, for the sum named. I do not believe that three million dollars will do

it Therefore, if you get a fuel gas which will answer for manufacturing purposes, it will be an object attained which I hope yet to see accomplished, and which any gas man would be proud to have realized. Then if you can do that, supply fuel gas for heating bath rooms and for grates, etc., then you can use your illuminating gas as a gas which must come higher than any gas which you can afford to use for fuel. The manufacture and distribution of fuel gas will come later.

Mr. Harbison—I do not wish to be understood as entertaining the idea that I do not want the fuel gas for manufacturing purposes. I do. But that is not the object that we are after, so much as to supply what was said to be a public demand for a fuel gas. The public demand means a demand from the general public, and not from the select few who may be engaged in any special line of business. What I am anxious for is that it shall not only be a gas that we can furnish to manufacturers, but a gas that we can furnish to the public generally for domestic uses as fuel, instead of their hot air furnaces, and instead of their cooking stoves, in which they use coal; so that they can use the gas fuel instead. Can any system be devised which will accomplish that end? May we not hope that a system will be devised which will enable us to make this gas and furnish it at a price which the people can afford to pay, and which they will pay, and which at the same time will pay a profit to the manufacturers? The statements given by Mr. Young are the most definite of anything that I have yet seen with regard to the cost of doing this work, and the most satisfactory evidence that I have yet heard on this subject. I have heard it claimed it was not necessary to have storage capacity in the use of a manufacturing or fuel gas. I have heard that claimed by parties engaged in the business. I doubted the statement then, and I doubt it still. There is no company furnishing fuel gas that can manufacture a supply in a satisfactory manner unless they have storage capacity. We are always liable to accidents, and to changes in temperature which necessitates extra storage capacity and additional outgoes. The gas cannot be made on impulse, or in a moment. We must have the stock in hand

that we have now every day to supply the demand. We cannot make gas now as fast as it is consumed in the hours when it is needed for illumination. We make it during the day and accumulate it for evening burning. We would have to keep a stock of fuel gas on hand in some way, and that would require larger holder capacity. I do not apprehend that any company can afford to go into the business of making fuel gas and put down a plant for that purpose, simply to supply a manufacturing demand, because manufactories are distributed over a large territory, and it would require an immense outlay of mains to reach them; and no price which manufacturers could afford to pay would compensate the gas company for this large outlay. We must have a large demand from the general public, sufficiently large to utilize the mains which we lay to supply the manufacturers. The figures given by Mr. Young would seem to indicate that the fuel gas of which he speaks can be distributed for about 18 cents per thousand feet. There is included in that cost of distribution the necessary outlay for repairs and maintenance. A company that is furnishing fuel gas to-day, as we have recently seen, is selling its gas at 30 and 40 cents per thousand feet, and measuring it by meter; and yet it is admitted by the managers that they have never made a dollar, but that they have lost a great deal of money in their efforts to introduce it, and have not yet been able to pay a single cent on their capital. Other companies manufacturing and selling fuel gas at 50 cents per thousand feet have gone into bankruptcy. One company in New England is to be sold at auction —the entire plant—within a couple of months of this time. Now, if this gas cannot be put at a price which will make the heating value of it equal to coal at $6 per ton, how can we get a price for fuel gas and sell it at a profit?

MR. GRAEFF—I would like to ask Mr. Harbison if the company which he refers to as the one not able to make any money is not the company at Jackson, Michigan.

MR. HARBISON—I do not know that I ought to state just what company I refer to.

MR. GRAEFF—Then I would like to ask him if it is not a company which has been spending a good deal of money on its

plant and in extensions, and whether that company has had a complete plant for a sufficient length of time to demonstrate whether it can make money or not.

MR. HARBISON—That would not change the correctness of my statement.

MR. GRAEFF—But it would change the strength of the argument.

MR. HARBISON—No; for the reason that the cost of enlarging the plant ought to be charged to the capital account, and not to the cost of producing gas.

MR. GRAEFF—In other words, the company has not yet got upon a basis which will enable it to demonstrate whether it can make money or not.

MR. HARBISON—The company which I allude to has been doing business for two years.

MR. GRAEFF—But on a very small basis.

MR. HARBISON—They are making considerable gas now—I do not remember just what amount; at any rate, they have been working it for two years. They claim that they have now got to a point where they are not losing money, and they hope to increase their business so as to make something, and I hope they will. I hope they will be successful in their operation, and make money, and show us that we can do the same thing.

MR. GRAEFF—The company in New England to which Mr. Harbison refers never was anything but an experiment. It was used, by the party who founded it, as a basis for the establishment of a syndicate that did not get established. I do not like to see an instance of that kind quoted, or a bankrupt company quoted, as an argument against the possibility of success.

MR. HARBISON—I do not wish to be understood as arguing against it. I am quite in favor of it. I wish to see it succeed. I am anxious to have some one show me that I can afford to introduce it in the city of Hartford, and produce gas there for fuel that the people will want and will be ready to pay for, and

which I can furnish at a rate that will enable me to make something on the investment. That is what I am anxious for. I am not speaking against it. I am seeking to encourage those who are engaged in it. What I want is to get at the facts in the case. The country has been flooded sufficiently well and long with statements that would not bear the light of day, and it is the facts that we are after. That is the reason why I moved that Mr. Clark be requested to continue in his work, and give us some additional facts a year from this time.

MR. GRAEFF—I would like to ask Mr. Young how much holder capacity he thinks would be necessary for fuel gas.

MR. JOHN YOUNG—I think, in order to be safe, that it would be necessary to increase the day storage.

MR. GRAEFF—How much would be necessary in furnishing a million feet of gas per day to a manufacturing establishment?

MR. JOHN YOUNG—That is a different matter altogether.

MR. GRAEFF—Why can there not be some analogy between the two? If a manufacturer can use a million and a-half cubic feet of fuel gas per day, and use a holder of not more than thirty thousand feet capacity, why must there be a full day's capacity of storage for general distribution?

MR. JOHN YOUNG—There are various reasons for that. The manufacturer starts up his works in the morning, and he runs usually at about the same capacity the whole day; and you have to make about the same quantity of gas every day. I think that is very much the case. Then, if his machine breaks down it is only the manufacturer who loses; but if your machines break down, or anything goes wrong, you inconvenience the whole community. I think that the same rule would apply to fuel gas that applies to illuminating gas. You would have to have your make pretty nearly uniform, or else it would have to be very expensive. Suppose that you had to make fifteen million feet to-day and twenty-two million feet to-morrow: it would be very expensive to get the apparatus and men together to make that extra seven million cubic feet. If you had the storage capacity you could go on working regularly and thus provide against any break-downs of your plant, or any other

accident that might arise. It is a very serious matter to put everybody in a town in darkness, and it is a still more serious matter to please everybody in a town. But you can get a candle or an oil lamp to take the place of illuminating gas, whereas if a man has his grates and stoves fitted up for burning gas it is quite different, and a far more difficult matter to get the gas burners out and get coal in the grates and stoves for heating.

MR. GRAEFF—Would you not make that gas continuously? Could you not devise a system which would make the gas continuously?

MR. JOHN YOUNG—Certainly; and that is my idea of making the gas.

MR. GRAEFF—Then you would make about a million feet per hour?

MR. JOHN YOUNG—To make it continuously you must have your demand contiunous, or else you must have storage capacity.

MR. GRAEFF—If you are going to make gas continuously, and set the limit that your plant shall make at a certain quantity of gas every day, then you must have a steady demand for it; but I do not see why it cannot be regulated upon a large scale just as manufacturers require it. If on one day they want a million feet, and on another day a million and a-half, I do not see why, with a steady capacity of one million feet per hour you must need a storage capacity for twenty million feet.

MR. JOHN YOUNG—But you do not use a million feet per hour each of the 24 hours.

MR. GRAEFF—But you have your generator capacity ready to supply any extra demand, as it increases.

MR. JOHN YOUNG—You would have the men idle during eight or nine hours a day, and your plant standing idle.

MR. GRAEFF—I think that would be better than carrying such large storage capacity.

MR. JOHN YOUNG—Your storage capacity is only what it costs.

Mr. Graeff—I would like to say one thing more, that, as a fuel gas enthusiast, I feel very much indebted to Mr. Young for presenting the points he has made in such a practical manner. What those who are advocating fuel gas wish to know is, what are the difficulties which lie ahead in their path; and I think that Mr. Young has presented the difficulties which lie ahead of the fuel gas men in a very clear and able manner, and I think that every one should be obliged to him. I would like to suggest that we seem to be getting more into a discussion as to the application of gaseous fuel for manufacturing uses, whereas I think that what this Association needs more particularly to know and understand is the application of gaseous fuel for general uses. The question of manufacturing gaseous fuel for manufacturing uses is settled. Its success is settled. If Mr. Young or any one else will come to Philadelphia I will show him or them where gaseous fuel is doing to-day what gas has never done before in a like establishment; and I will show it to him upon the word of a man whose statements no one will question. The working of gaseous fuel as regards manufacturing establishments is settled. I think that what we want to bend our energies towards is finding out how it can be made to serve best our own private consumers. In that line I think that Mr. Young has done us very good service, and I wish to thank him.

Mr. Robert Young—There is one thing I notice in my brother's paper. He assumes that a gas having 400 heat units per cubic foot might be got to do the same amount of work we are now doing with a gas that has 1,000 heat units. My advice to him would be, if he makes an attempt to heat the average house in Allegheny with 2,000 feet of gas having only 400 heat units to the foot, he had better be in Baltimore or some other distant place. I noticed from observations taken at my meter last winter (which was a very moderate winter in our section of the country), that on some of the coldest days it took 5,000 cubic feet of gas, which had 1,000 heat units per foot, to keep my house comfortable. I am very careful not to let the temperature get above 70°. The halls are kept at 70° by a hot air furnace which I built expressly for using gas. The only place that

I see where it is extremely wasteful is the cooking range. I am sure 50 per cent. more gas is used there than is really necessary. I am talking now of our present method of using the gas, but I think a great deal has to be learned how to utilize a greater amount of the heat developed from the gas than we do at present. I don't see how we can assume that a gas having 400 heat units can be made to do the same amount of work that gas having 1,000 heat units can. We are very anxious to get a fuel gas, and I think it is to all our interests to study the fuel gas question.

MR. CORNELL—This is a very interesting subject, and the views which Mr. Young has expressed bring before us very clearly and fully the difficulties in the way of this enterprise in which we are all engaged and which we are looking forward to as promising to be successful in the future, and in a future not very remote. I think these difficulties which appear before us come pretty largely from the fact that we reason from analogy. The analogy of making illuminating gas is the one which brings out a very formidable difficulty, and which Mr. Young presents very clearly to us—and that is the amount of storage capacity required. Yet we must remember that in illuminating gas we make for the whole 24 hours, and desire to make it continuously during 24 hours, that which we only use during five or six hours; whereas for fuel gas we are making it for continuous consumption throughout the 24 hours. That fact greatly modifies this question of storage. I think it is entirely practicable, and with all deference to the experience of Mr. Young, as stated to-day, I think there is no proof that it is not entirely practicable to get along without such a large amount of storage, and to make such an amount of gas as would be required to supply the demand. If there were 30 or 40 actual producers, and if 15 or 20 of those were in actual use all the time, and five or ten more were in such a condition that they could be brought into use within a few hours, I think there would be no great difficulty in providing for the increased consumption—for a suddenly increased consumption—without anything like a day's storage, and with possibly but a few hours' storage. That is one way in which I think that our analogies are apt to bring us into trouble. If we can throw away those analogies of storage as they relate to illuminating gas, I think we can dispose of the difficulties

which are presented. Another one which comes up very clearly and directly is the analogy from the use of natural gas. In the use of natural gas, where it is very abundant, and where it has been furnished at very low prices, the whole community have been using it, so that a very large amount was used, and the use was very wasteful, so that it took an enormous amount. But, in using manufactured fuel gas we must conclude that it is to be used not on the basis of coal, but on a very much higher basis; and that it is only those people who can afford to pay, and who will pay a very much higher price for the increased healthfulness and cleanliness of gaseous fuel, that are going to use it at present. Therefore, we may reduce the amount to be supplied. In Allegheny the 7,500 users would have to be reduced to a third of that number, and the price increased to such an amount at least as coal would cost in Allegheny or Pittsburgh, and so remedy in part that difficulty. I think we must look in this direction for a great modification of the difficulties which Mr. Young presents.

Mr. Harbison—I wish to call special attention of members of the Association to the remarks of the President in his address this morning on this subject of fuel gas, and particularly to that part in which he alluded to what was being done with gas stoves. I want to reply to some statements which have been made in this town within 24 hours, more or less, with regard to the town in which I live when I am at home. We have there in use about 1,600 gas stoves. We are selling more than 20 per cent. of our entire output of gas between seven o'clock in the morning and five o'clock in the afternoon. Notwithstanding the immense inroad which has been made upon us by the introduction of the electric light in past years (it having taken away nearly 1,400 street lamps), during the past four months we have sold much more gas than we did in the corresponding four months of last year. (Applause.) During the month of September (notwithstanding we sold a year ago in September, nearly 70,000 feet of gas for lamps) our output for the month of September was more than half a million feet above what it was a year ago.

Mr. Robert Young—What are you doing with gas stoves?

Mr. Harbison—We are selling gas in Hartford to-day at

\$1.25 for certain purposes; and I can show as good things there as Mr. Graeff can in Philadelphia. Come and see them.

Mr. Robert Young—Suppose that you had no gas stoves there what would be the difference with regard to the amount of gas consumed? Suppose that you took your stoves out altogether, would not the amount of your gas used for illuminating purposes be much affected?

Mr. Harbison—Then we would turn our attention to displacing the electric light—as we are doing now. One store there where they have been using sixteen incandescent lights, we are going to light with gas before the week is out.

Mr. Robert Young—That is what you ought to do. How much of the business of the gas company have the electric people taken? That is what I would like to know.

Mr. Harbison—In our city one-eighth of the entire output was sold for public lighting, and that is all gone.

Mr. Robert Young—You have no idea how much for private lighting?

Mr. Harbison—No, but although they have taken a very large amount, yet we are now where we were a year ago.

Mr. Robert Young—That is largely owing to the gas stoves, and not to the use of gas for illuminating purposes?

Mr. Harbison—There is a very large increase for illuminating purposes as well as for gas stoves.

Mr. Starr—The increase I imagine is very largely due to the low price of the gas.

The convention adjourned to October 17th, 1889, at 10 A. M.

Second Day—October 17—Morning Session.

The Association was called to order at 10.30 A. M.

Introducing Mr. Corbett Woodall.

The President—We have with us to-day a gentleman well known to most of you as a prominent gas engineer of London,

Mr. Corbett Woodall, and with your permission I will invite him to take a seat on the platform. (Applause.)

Mr. Woodall.—*Gentlemen:* I hardly expected that the President would be good enough to introduce me to you in this manner, and I am sorry to confess that I find myself with very little to say to you. I feel my mind very full of sentiments of thankfulness for the very great courtesy and kindness with which I have been received by all my professional brethren on this side of the water; and although I have no authority at present to speak as a representative of the Gas Institute on our side of the water (to my great regret not being a present member of that body) yet I am quite sure that I only interpret the feelings of the great body of English engineers (gas or otherwise) in saying that the recollection of all the kindness that has been shown by you Americans to our countrymen visiting this country, has made them most anxious for an opportunity to reciprocate those many kindnesses on our own side. (Applause.)

I cannot help feeling this morning drawn back to two little episodes in connection with your Society, and with our own people at home, that have been fully in my mind ever since I found that I was able to have the pleasure of attending this meeting. One of them was the meeting of our own Society which was attended by certain members of yours, in the year 1878, and when I had the pleasure then to welcome one of the men whom I then held, and shall always hold, in very pleasant memory—Major Dresser—together with Mr. Forstall and Mr. Greenough, when they came over to attend the meeting of our Association, of which I had the honor at that time to be President. I assure you that the recollection, especially of our late friend Dresser's amiable, kindly, cheerful, admirable spirits, will take a long, long time to efface from the memory of those who were present on that occasion. I cannot help thinking also this morning of another gas man who, two years ago, stood very much in the same position in which I have the honor to stand to-day before you—my old friend Mr. Spice. I am sure that those of you who met him must share the regrets that we felt on our side when he was so suddenly taken away from our midst.

I know that you have a busy day before you, and that I am simply wasting your time by attempting to make a speech to you; but I must ask permission to say how struck I have been with the differences in the character of the work that you are called to do in comparison with that which occupies us at home at the present time. The variety of the questions and problems that you have before you is something almost bewildering to one who for a comparatively long period has gone along the steady course of simple coal gas making. One of the things that made me particularly glad to come to this meeting to-day is the opportunity presented for studying the question of the distribution of fuel gas. I find many of you very largely engaged in the manufacture and distribution of water gas, and I find many of you not simply making and distributing gas, but also carrying on the business of electric light engineers and suppliers. The whole thing is so much fuller—I will not say more complicated—but giving so much wider scope for individual effort, thought and enterprise, that it has added very much indeed to the pleasure I have in visiting your works. In the manufacture and distribution of coal gas I think that we are able still to hold our own pretty decidedly in comparison with American works; but in all these other respects we have a very great deal to learn. I can only say in conclusion that I am extremely grateful for the readiness which I find on your part to communicate the many interesting things which you have to say. (Applause.)

Other Introductions.

Mr. Harrison—I understand that President-elect McMillin, is in the room, and I move that a committee be appointed to escort him to the platform.

The President—I will appoint Mr. Harbison to be that committee.

(Mr. Harbison escorted Mr. McMillin to the platform.)

The President—Mr. McMillin, it gives me very great pleasure to know that when I vacate this Chair it will be occupied by a gentleman of such well known ability as yourself. (Applause.)

Mr. McMillin (President-elect)—I would much rather listen to your applause than to my own voice. Never having appeared before a gas convention before it is a little bit embarrassing. Having been forbidden by my physician to attend the convention at all, you will excuse me, I know, for not attempting to make a speech upon this occasion. I obeyed the mandate of my physician until I got the dispatch last night notifying me that I had been elected President of the Association. Then I could not stand it any longer, but came over to bow my acknowledgements; and that is all that I can do this morning. I want to add my congratulations upon the very large attendance. I am delighted to see so many here, and I trust that the attendance may be quite as large next year. (Applause)

The President—I notice that we also have with us to-day General Louis Wagner, Director of the Department of Public Works of the City of Philadelphia. He has a still higher title—that of gas man. I invite him to the platform. (Applause.)

Mr. Wagner.—You will pardon me if I speak from the floor; I am not entitled to the honor of an invitation to the platform. Unlike the President-elect, who has never appeared before a gas convention before, and now disobeys his physician by coming here, I was told by my doctor that I was sick and ought to go away from home a day or two for the purpose of recovering lost health and strength; and where could I better do that than in a gas convention. Of course in what I may say, I do not speak from experience except in so far as I have gained experience in reading the proceedings of this eminent body, and of eminent bodies like this. I trust, as the President-elect does, that the attendance next year, and for years to come, will continue large, and that the exercises will be as profitable at this convention, and also at succeeding conventions, as they have been in years gone by. If they shall cease so to be I do not know what will become of the gas business in this country. And of course, in England, as we have learned of our friends from abroad, their movements are influenced and directed to a very great extent by what they hear and learn from America. So far as the gas business in Philadelphia is concerned, I may say that we have there a great deal of various kinds of gas. A

little girl of mine once had given her, as the subject of an essay, "Milk," and she wrote, "there are many kinds of milk;" and so I say that there are many kinds of gas in Philadelphia. Of course, you don't have the same variety that we have in our city. Of course we have illuminating gas, as you have everywhere. We used to have a gas in Philadelphia that did not illuminate very much; but now it does very nicely. But we labor under particular and peculiar disadvantages, or have been doing so until the last year. My friend Park, who has been Chief Engineer of the Philadelphia gas works for many years, has, I have no doubt, told you all about it. He was handicapped in his business for the last few years because he had twelve men to manage him—twelve bosses in the gas business, I mean—each of whom knew more about it than he did, and each one of whom wanted to run the gas works in his own peculiar way. When that condition of affairs was changed, and one man was set to direct not only the gas business, but the public works generally, who did not know anything about gas, then, of course, Mr. Park could do just as he pleased, and the reports, of which he has sent you copies during the last three years, show you that he has been pleased to do right well; and all that we have accomplished in Philadelphia is due entirely to his efforts. Of course, when I get back from this convention, having learned all that there is worth knowing about making gas (as I shall at the close of the session to-day), I shall set up as a boss and tell him how to make gas. I sincerely hope that nobody will try to lead me astray in the gas business, because if I should learn anything wrong there will be lots of trouble as the result when I get back to the city. I am glad to be here. I want you to believe that, although everybody says it. I have no doubt, if we all had our desserts, that some of us would be in heaven, and others of us would be in a locality where they do not need gas for illuminating purposes. But I am glad to be here. I am sure that I shall be benefited by being here, and that I shall learn much that is worth carrying back to Philadelphia. Of course everything that is said here is gospel truth, and everything we learn here is of the very best, and so I will take it all back to Philadelphia and apply it all there to the best of my capacity.

THE PRESIDENT—We also have with us this morning Mr. Williams, of the United States Census Bureau, who would like to say a few words to you with regard to collecting the statistics of our industry for the next Census Report.

MR. WILLIAMS—I am here as the representative of the United States Census Bureau, for the purpose of laying before you the facts necessary to secure the co-operation of all who are interested in the manufacture of gas, to enable us to present such a report in the next census as we hope and believe will be complete, valuable and interesting to those engaged in this industry. Owing to the death of Major Dresser, who was selected to collect statistics of the gas industry for the census report of 1880, we were unable to present any statement whatever in that report. But it is the desire of the present Superintendent of the Census to have a complete exhibit made for the gas industry, as well as for all other industries; and it will rest entirely with those interested in that industry to determine how full and accurate that report shall be. We desire to select some gentleman to be entrusted with the investigations of that subject, who has the confidence of all who are engaged in gas manufacturing. Just who shall be selected for that purpose will depend very largely upon the wishes of this Association, and of those engaged in the manufacture of gas. I bespeak for him the same co-operation that we have the promise of in other lines of manufacture throughout the entire country. I have visited various cities of the country, and the manufacturers uniformly promise co-operation with the different persons selected to conduct the investigations. I want to say, in conclusion, that I hope the members of this Association will think seriously of the matter, for of course we are all interested in making for the gas industry the best possible report that can be made.

THE PRESIDENT—The first paper to be read this morning will be that by Mr. W. H. Pearson, on

THE CONDUCT OF THE ELECTRIC LIGHT BUSINESS IN CONNECTION WITH THE GAS INDUSTRY.

Mr. Pearson—I will state, before commencing to read my paper, that I have made one or two alterations in it, relative to the percentages and statistics given of the gas companies of Massachusetts. When I prepared my paper I did not notice that there were a number of lists of those companies, and I took a list which was not complete. That will account for the differences which you will find in the percentages.

The question of the desirability of a gas industry, in connection with the electric light business, being operated by the same company, is one regarding which, there will naturally, be considerable diversity of opinion, and one, indeed, upon which, I am free to admit, I have been induced to change my views. At the meeting of this Association, two years ago, I strongly opposed gas companies having anything whatever to do with electric lighting, but further and fuller light upon the subject has caused me to think differently, and I have recently come to the conclusion, that, on the whole, it would be advantageous for a gas company to manufacture and sell both kinds of lights; and it will be my purpose, in this paper, to advocate that side of the question. In doing so, however, I must express my regret that, owing to the strange course taken by the Toronto City Corporation, in refusing the Consumers Gas Company the right to use the streets for electric wiring, I am not in a position to speak from practical experience in electric lighting, but as doubtless there are gentlemen here who have had this experience, they will be able to supply information which I am unable to give.

The rapid progress which has been made in electric lighting during the past few years, and which is continually going on at an increased ratio, must of itself be conclusive evidence to any unprejudiced mind that it has "come to stay," and that, as at present, it is destined to continue to be one of the principal, though not, in my opinion, the chief lighting agent of the future; for on careful investigation I am satisfied that neither the arc nor the incandescent light can compete with good and cheap gas, as the light for the people, and while there are some who can and will have luxuries, or what they consider to be the best,

at any price, with the general public the question of cost is the factor which has the most weight.

Admitting that electric lighting is to be a permanent industry, and that it will have a field that would otherwise be occupied by gas, why should not the two systems be conducted under one management? My first reason for claiming that they should be is that a gas company would be able to furnish the light more cheaply than an independent electric light company would in the same place. A gas company must have an executive head, who is usually a man of sound judgment and intelligence, with a good practical knowledge of the various mechanical and other appliances, including the economical production of steam, and having experience in the purchase of supplies and of the best markets in which to obtain them and also having a large experience in dealing with the public. He is, therefore, in these respects, better qualified to supervise the operation of an electric lighting business than a novice. The gas company being already organized and officered, the combination of electric with gas lighting would cause comparatively little or no additional expense for the directorate and management, and the two businesses could be much more economically conducted. Again, in most gas works, there is generally ample space in the grounds for a building, or, what is better, room in a suitable building already erected, in which to erect an electric light plant; nor will any additional office room be required. The saving in the interest on the cost of these buildings, therefore, would alone amount to a considerable sum, while the opportunity for the profitable utilization of some of the by-products of the gas business would be another item of saving.

To my mind, however, the most important reason for a gas company going into the electric lighting business is to head off ruinous competition.

We all know that, when seeking to obtain a foothold in a city, the first thing the promoters of an electric light company do, is to systematically and persistently canvass the gas consumers, and offer to supply them with their light, say, for a certain period, at the same price they have been paying for gas, and sometimes at almost any price. By this means, they often succeed in obtaining a large number of customers, who other-

wise would not have adopted the electric light, and when, at the end of the term of agreement, the electric light companies are driven to increase their price to an amount that would pay a fair interest, the consumers, having gone to the expense of wiring and lamps, and disliking to have to "knuckle down" to the gas company, sometimes keep a number—if not the whole —of the lights, which otherwise they would not have retained. Now, if the gas company had had control of the lighting, they should not, and probably would not, have sold the light excepting at a fair profit, and to supply a legitimate demand, and consequently would have retained a number of their consumers, lost through this ruinous competition. Again, if the electric light business was in the hands of the gas companies, corporations would not put up electric lights in the reckless manner they do now, at three or four times the cost of gas, simply because the companies offering them are in opposition to the gas company, or because of the persistent importunity and the powerful influences brought to bear upon them by these opponents of gas. There would, therefore, be fewer electric lights and more gas lamps—much cheaper, and, at the same time, quite as effective street lighting—and, consequently, the interests of both the citizens and the gas companies would be promoted.

The circumstances of a company will determine the degree of the importance to it of going into the electric lighting business. It is, of course, usually much more important for a small company to adopt electric lighting than for a large one, owing to the necessarily high prices charged for gas, rendering electric lighting competition more injurious. Again, a gas company having full employment for all of its plant, and contemplating extensions, will be in a much more favorable position to operate the electric light than one with ample space and apparatus for a much larger business, as, instead of extending its gas business, it could adopt electric lighting, while in the latter case, the introduction of the electric lighting plant would continue to keep their superfluous gas plant without employment.

An important enquiry here presents itself :—Would gas companies adopting the electric lighting shut out all opposition? That would depend a great deal upon the financial strength of

the company, and the manner in which it has conducted its dealings with the public. Few local electric light companies would be willing to "tackle" a gas company, strong financially, provided the latter's prices for electric light are fair and reasonable, and it is prepared to supply every legitimate demand.

As opposition in lighting has proved to be productive of unnecessary and wasteful expenditure, and consequently detrimental both to the interests of the gas and electric light companies, as well as to the public, I hold that the civic authorities should, with certain restrictions and safeguards, give the monopoly of the electric lighting, as well as the gas, to the first in the field, thereby securing to the citizens the cheapest light they can obtain; for, as experience has shown, ruinous competition has almost invariably resulted in combinations and increased prices, owing to the necessity of having to pay interest upon the large amount of unnecessary capital, and to make up for previous losses. I am afraid, however, that it will be a long time before corporations will learn this common sense lesson.

I do not wish it to be inferred from anything that I have said that I contemplate, from the opposition of electric lighting, anything approaching disaster to any fairly large and well organized gas company, or to any company in a position to sell gas at a moderate price, and drawing my conclusions from what has already transpired, am satisfied that with regard to such companies the worst that could happen would be a reduction in the ratio of increase in the business of the company heretofore maintained, or the maintenance of the *status in quo*. After a good deal of enquiry, I have failed to hear that any good sized company has failed to maintain at least the consumption of the previous year.

As the admirable report of the Board of Gas Commissioners for the State of Massachusetts, for the year ending June 30th, 1888, may not have been accessible to most members of this Association, some extracts and deductions from that report, in corroboration of my claims, will doubtless be of interest. This report contains the statistics of 60 coal, and 10 oil gas companies, and partial statistics of some 50 electric light companies. The names of 70 companies being given in addition to 12 gas

light companies operating electric lights. Fifty of these coal gas companies show an average increase in the consumption, over the preceding year, of 12.68 per cent. For three there are no returns showing increase or decrease, and seven show a decrease in the consumption. Four of the oil gas companies show an average increase of 13.64 per cent.; for two there are no returns, and four show a decrease. Electric lights are supplied in thirty-seven of the places where there are gas companies, and the average increased consumption shown for these gas companies is 11.85 per cent., there being only seven gas companies where there are opposition electric light companies that show a decrease in consumption. It is to be regretted that the increase or decrease in the electric light business is not given in the report referred to. Twenty-seven of the gas companies referred to had during the year reduced the price of gas, 20 of which are opposed by electric light companies. That in the aggregate these gas companies are doing a fairly paying business, and are in a sound financial position, is evident from the following facts. The dividends paid by 64 of them, range from 0 to 20 per cent., and average 5.15 per cent. The report of the other six is not given. The aggregate surplus and reserve funds of these companies amount to 23 per cent. on the paid up capital. With one exception, the companies not paying dividends are very small ones. The following statement will, to some extent, show the nature of the competition with which they have had to contend: The average price charged per hour for a 16-candle incandescent electric light, for commercial lighting, in the cities of Boston, Cambridge, Lawrence, Lowell, Springfield and Worcester, is 1.28 cents, which is equal to $2.56 per thousand feet for gas of the same illuminating power, while the average price charged for gas in these places is $1.48 per 1,000, the average price for nominal 2,000 candle arc lights for municipal lighting, all night, being 55 cents. The average increase in the consumption of gas in these places, over the previous year, amounted to 9.47 per cent. These are fair samples of the electric lighting charges made throughout the State, where water power is not employed.

From the above statements it appears evident that gas lighting is more than holding its own in Massachusetts (and I take

it to be a fair illustration of the position of the industry throughout the United States) and that incandescent lighting cannot there, at all events in the larger cities, begin to compete with gas in price. Whether or not electricity, at the prices charged in Massachusetts, is paying, does not appear, as there is no statement in the report referred to of dividends paid by electric light companies, as in the case of gas companies. This, of itself is suspicious, as if fair dividends were paid, it is not likely that the fact would be suppressed.

While I am an advocate, for the reasons above given, of gas companies adopting the electric light, I should be sorry to have it understood that I yield to some of the claims to superiority made by the promoters of electric lighting. That it does not vitiate the atmosphere, throws but little heat and does no injury to decorations, plate, etc., I am quite prepared to admit, but the vitiation of the atmosphere, by properly purified gas, is by no means as serious, nor as injurious to decorations, etc., as is sometimes claimed by its opponents, and while the electric light does not vitiate the atmosphere it cannot be utilized in ventilation as gas can. The advantage or disadvantage of the heat thrown out by gas is really a matter to be determined by the kind of climate in which it is used. In the northern parts of the United States and in Canada there are only two or three months in the year in which the heat of the weather causes any annoyance, while, during the rest of the year, the gas is found to be a positive advantage in supplementing the heating from other sources. As an illustration that this is recognized by gas consumers, one of our largest hotel keepers told me recently that it prevented his having to light his furnaces weeks earlier than he otherwise would, and this, he said, was one of the reasons why he did not care to put in the electric light; and it was only a few days since that another of our customers declined to put in the electric light, because it would necessitate his putting a heater into his restaurant.

As to steadiness, we all know that a perfectly steady light can be obtained from gas by the use of proper globes and by many of the different kinds of burners, and that the gas light is not subject to the deterioration which takes place in incandescent lights, often after the lamps have only been in use for

a few days, nor to the fluctuation in the candle power of the arc lights. Nor am I prepared to yield the palm to electricity for street lighting, as I am satisfied the streets can be as effectively, and in many places more economically, illuminated with gas. For instance, two high candle power lamps, consuming 20 to 25 feet of gas per hour, placed 200 feet apart, though not giving as brilliant illumination around the lamp, will give a more satisfactory lighting than so-called 2,000 candle—(actually from 400 to 500 candle power)—arc lights placed 400 feet apart.

An important element to be considered is the question as to whether the cost of the production and the selling price of electric lighting can be materially reduced.

Unfortunately, in discussing this point, not being an electrical expert, I am placed at a disadvantage, but I think we have some data to enable us to come to a fairly accurate conclusion. It is hardly likely that the high efficiency of the engines used in many places (using say less than 3 pounds of coal per horse power) can be much improved upon, or that the very low prices of carbons (now less than a cent each) can be much reduced, while the introduction of the alternating system of incandescent lighting seems to have reduced the cost of wiring to a minimum. It is pretty generally admitted among electricians, that a 2,000-candle arc lamp requires one horse power, and 14 is about the highest number of 16-candle incandescent burners obtainable per horse power, that I have known to be claimed. Whether better results than these can be obtained is a matter for consideration.

It does not, therefore, appear as if there could be any very important reduction made. Moreover, it is admitted, that in numerous places, the electric lighting business had not been a profitable one, and certainly, higher prices will have to be charged in those places to put it upon a paying basis. At all events, as an offset (as far as large cities are concerned) against the probable reduction in the cost of production, the probability that the authorities will require wires to be placed underground, which means about three times the cost of overhead wiring, must be taken into consideration.

It must be admitted that the prices now charged by manufac-

turers for electrical apparatus are generally far too high, and, doubtless, a very material reduction will be made, in the course of time, which will score in favor of electric lighting.

The use of electric motors is, of course, a valuable adjunct to the business of incandescent electric lighting companies, and one which will doubtless increase, and is, therefore, a factor to be taken into account.

It must not be lost sight of, however, that important reductions and savings are constantly being accomplished in the manufacture and distribution of gas, and that there is equal probability of their fully keeping pace with the reduction made in the cost of electric lighting.

A consideration of the prices paid for electric lighting throughout the United States generally will not be out of place, and this information is furnished by Whipple, in his "Municipal Lighting (1889)." In this interesting volume, he gives a list of the prices charged for public lighting in 316 cities and towns in the United States, where the streets are wholly or partly illuminated by electricity, of which the following is a partial summary. The highest price paid for an arc light of 2,000 nominal candle power, burning all night, is $360 per annum and the lowest $40. Between these two extremes are 186 prices, a few of which I give below: $280 per annum (56 lamps); $255 (100 lamps); $252 (44 lamps); $237.25 (704 lamps); $233.60 (25 lamps); $200 (170 lamps); $60 (100 lamps); $85 (65 lamps); $80 (14 lamps); $75 (33 lamps); $73 (20 lamps); $60 (55 lamps); $57.60 (75 lamps).

The highest price charged for lamps burning till *midnight*, is $273.73, and the lowest $47.00 per annum, and the following are a few of the intermediate prices charged: $196 (56 lamps); $182.50 (17 lamps); $146 (16 lamps); $75 (55 lamps); $75 (22 lamps); $60 (26 lamps); $50 (17 lamps).

The difference between the highest and lowest prices charged for lamps burning all night, is 482 per cent., and between the highest and lowest for lamps burning till midnight, 386 per cent.

It is clear that no local conditions could legitimately cause anything like such a great variation in prices of electric lighting. It would seem as if electric light companies simply obtain the highest prices they can get, and for the sake of "getting

in," would take any price, and that it is largely a matter of shrewdness on the part of the officials on both sides, as to the price paid.

It is evident these highest and lowest prices cannot be maintained; and the question arises, when they come down to a fair average, say $146 per annum, or 40 cents per night, will there not be a reaction in a number of places in favor of gas lighting? Whipple gives the average cost for arc lighting, as $121 per annum, but from information which I have, I think 40 cents per night would be a fairly paying price, where a large number of lamps are taken, and I consider at that price, high candle power gas lamps come into successful competition and give a more satisfactory illumination.

From careful enquiry and investigation, I am satisfied that in the average place, incandescent lighting cannot be furnished to pay a moderate dividend, at less than one cent per hour, for a 16-candle lamp, which is equal to gas at $2.00 per 1,000 feet. In the city of New York, I am informed that the Edison people are charging 1 1-5 cents per hour, which is equal to gas at $2.40 per 1,000 feet, and that they pay a dividend of 5 per cent., and their stock is quoted at $75 per $100; I also understand that in their down town station their business is not increasing.

To conclude, I consider that if a gas company can obtain the control of electric lighting, by all means let it do so, but if it cannot I do not think it has any very great cause for alarm or discouragement; for, I am satisfied, as regards most places, that if proper attention is paid to the introduction of gas for heating, cooking and motive power, the increase in consumption from these sources will more than compensate for the loss owing to the introduction of the electric light. As far as the Manager is concerned, it need not personally be to him any source of regret; for, as a rule, there is quite enough in the gas business to occupy his energies to the fullest extent, and that the wear and tear from it is quite sufficient, without the addition of that which must of necessity arise from the adoption of electric lighting.

Discussion.

The President—This is a very interesting and instructive

paper. I suppose many of our menbers already have both systems running, and others are thinking of taking up the electric light business. I hope the paper will receive very full discussion.

MR. ROBERT YOUNG—Does Mr. Pearson think that, where an electric light plant is already established, whether a gas company can successfully compete by saddling an electric light plant on their own works? That is, whether a gas company can compete in electric lighting with an electric light company already doing business in the same city.

MR. PEARSON—I would think not.

MR. ROBERT YOUNG—It seems to me, such an increase of competition would only have a tendency to increase the cost of electric lighting, and that would affect the price of gas. Of course in a city where no electric light plant is already established, and the city desires the electric light, I would say it would be better for the gas company to supply that light than to allow a competing company to do it. But I do not think it would be advisable, where there is an electric light plant already established, for a gas company to enter into competition with them.

MR. STINESS—Did I understand the question of Mr. Young to be whether it was advisable for a gas company, where there is an electric light company already established, to enter into the business of electric lighting either by its own corporation, or by consolidation with a company already established? I understood Mr. Pearson to answer in the negative. To that answer I desire to take issue. Although there may be individual cases where such a course may not be advisable, yet in our own New England I can scarcely name upon my fingers the instances where such a combination or consolidation has not been for the financial interest of the company as well as for the benefit of the people. I know by experience that there are many companies doing a very successful electric light business, and doing it in a way that gives the most perfect satisfaction to the public, by reason of the fact that they give all the means of artificial illumination, whether by gas, by the arc light, or by the incandescent light. In the report of the Gas Commissioners of

Massachusetts (which I consider one of the ablest papers that has been yet published in the gas world) I find no mention is made of the increase of business; and I suppose that that omission arises from the fact that electric light companies have not been compelled to report to the Commission until within the past year, and, therefore, there has been no chance perhaps to make a comparative statement. But I think it comes to the mind of every man present here that the electric light business in Massachusetts is vastly increasing. I know this because I am a member of an electric club where these matters are brought to our attention; and I know that in very many cases this business is being done at a profit. Mr. Pearson quotes from Mr. Whipple's book the statement that in one instance \$360 per year is paid for an arc lamp burning all night. I would like to furnish them for \$130, and at that price will agree to pay a ten per cent. dividend. I would like to know where that place is. I think it is quite a remarkable statement. Mr. Pearson has given us some facts in his paper which come clear down to the present time and to rock bottom. I think that 40 cents a night for an arc light all night long is a good paying price. Mr. Whipple's book may be quoted as an authority by some, but I attach very little value to it. I think that the consolidation and combination of gas and electric lighting, taken in its infancy by a gas company, has proved a blessing to all. While perhaps it may not be appropriate here to give an exact statement as to cost, yet there is one matter which I think has been somewhat exaggerated. We know that in our gas business we charge a good price for the depreciation of our plant, yet I think that the depreciation in the electric lighting, say perhaps, in overhead wires, will compare most favorably with the depreciation of any gas plant. I have machines which have been running and wires which have been strung for more than five years without one single cent of expense for repairs. Undoubtedly in many companies which were organized simply for the sole object of selling a plant, and where they schemed and planned for the sake of selling stock, the depreciation in individual cases may be very large; but where a gas company establishes a plant in the same way that they establish gas works—for all time—the amount of the depreciation and repairs will compare very favor-

ably with those of a gas plant. I believe from my own experience that there are many places where to-day the business of electric lighting and of gas lighting can be carried on with profit to the company, by one company. There may be individual cases where this cannot be done with a profit; but I think they are the exceptions. I think experience teaches us it is best for the gas companies to control, as far as possible, all means of artificial lighting, except what is burned by the wick.

Mr. Pearson—I find that Whipple does not give the name of the company charging $360; but here is his statement: "The highest price paid for an arc light of nominally 2,000 candle power, burning all night, is $360." I have the names of the places that I found in his list and of some others where a high price is charged, and if desired I can give them to you. In Rutland, Vermont, for 56 lamps, $280; Savannah, Ga., $255, for 100 lamps; Sacramento, Cal., $252, for 44 lamps; Boston, Mass., $237 for 704 lamps.

Mr. Stiness—I do not see why I need say a word for the good city of Boston, but I think I may make the statement that I am positive they are not allowed to erect a pole in the city of Boston. Every particle of wiring in that city has to be done upon the tops of buildings; and to maintain those wires upon the tops of those buildings requires a corps of men that is perfectly astonishing. That is a reason why in Boston they are compelled to pay that high price. Being a Massachusetts man I want to stand up for the city of Boston; but what is said as to the high price paid in Boston does not alter the position which I have taken.

Mr. Littlehales—I entirely differ from Mr. Pearson and Mr. Young and agree with Mr. Stiness as to the desirability of a gas company going in for electric lighting, even where another concern is in possession; and I will tell you why I think so. We know that in most cases the same tactics have been pursued in starting electric light concerns that have been in many places, in times past, adopted in respect to gas companies. They have been started by speculators, and the plant has cost three times what it should have done. Within the past five or six years great progress has been made, by reason of which the apparatus

for producing the electric light has been cheapened, and the efficiency of electric light plants increased, so that to-day a gas company, or any one else, can buy a plant of any given capacity for one-half what it would have cost seven or eight years ago. A gas company going into the business now has all those advantages. And those advantages are not small ones. I am at the present time making application to the City Council of our city for permission to go into the electric light business, and we think we can see our way to a fairly remunerative trade. During my trip around in investigating that matter I came across a number of gentlemen who have had a very large experience in electric lighting, and I think that those gentlemen can furnish this Association with a great deal of valuable information if they can be induced to speak on the question. I may mention Mr. Chadwick, of Lockport, New York, and Mr. Faben, of Toledo, Ohio. Both of those gentlemen are in the electric light business, and I have no doubt can give us a good deal of information on these subjects.

Mr. Robert Young—Is it not to the advantage of the gas company, when speculators come into a town and expend a great deal of money in an electric light plant? They will have to charge more for their lights or make their stock of no value. The gas company might be able to put up an electric light plant that would be able to compete with them, but it would be done at the expense of the gas interest. I would be inclined to let the company with the large capital alone, for when a company has a large amount of money invested they will lose a good deal before they will give up.

Mr. Robert Baxter—I have listened with a great deal of interest to Mr. Pearson's paper, and also to the remarks of others. It is very pleasing to me to find that both Mr. Pearson and Mr. Littlehales have come around to the position which I took two or three years ago. At that time I sent a circular letter to the principal gas companies of the Dominion, placing several questions before them, and I had replies from them all. I think, with the exception of St. John, New Brunswick, they all said practically this: "We have enough to do in the gas business; there is no money in the electric lighting business; they

are making no money; they are going to the bad; and we have enough to do in attending to our own business of making gas." I am glad to find that they have now come round to the position which I took then—and it is the strongest reason which I have for advocating a gas company conducting an electric light business as well as its own. That, if the public want the electric light they ought to have it; and if they want it who can give it to them as cheaply and as efficiently as a gas company? I maintain that no new company coming into the field is so well-fitted to do the business as a gas company already occupying that field. These points have been brought out most admirably by Mr. Pearson in his paper, and I need not take your time in going over them.

In reply to the question as to whether it is expedient for a gas company to go into the electric lighting business in a city whére an electric light company is already established, I differ from Mr. Pearson and agree with Mr. Stiness. That is practically what the company I am connected with is about to do. Of course every company must be governed by the peculiar circumstances in which it finds itself. We were threatened with the species of persecution which has been so potent in the States. A company of "booming speculators" came to the town and organized a company with the deliberate intention of absorbing our company altogether, by buying us up, or buying us out, or forcing our stockholders to sell their stock below par and so enable them to gain control of the company. Under those circumstances my company decided to fight them with their own weapons, and, therefore, we installed an alternating system of about 1,500 lights, and are now running between 1,200 and 1,400 lights very successfully. We had, as I say, to fight them with their own weapons. We supplied the light at a very low price. I think that is the ground that gas companies ought to take, and I am glad to know that the number of those who are engaged in both businesses is increasing very rapidly.

Mr. McMillin—I am delighted to see with what facility gas companies can adapt themselves to the changed conditions of the times. Four or five years ago to mention water gas before a gas convention was like shaking a red flag before a bull's eyes;

but to-day we all take it. A year or two ago perhaps, certainly two or three years ago, you could hardly find in a gas convention an advocate of electric lighting; and I believe that my friend Pearson told us at New York, two years ago, that we had better let it alone.

Mr. Pearson—I confess that in my paper.

Mr. McMillin—Now, I think that the most of us will agree that the electric light is a right good thing to have about; and now the only thing that will stir up the Convention is to mention fuel gas; we will get there also after a while.

In St. Louis there are now five electric light companies, and that, too, after five companies had combined into one united company. Myself and associates, as individuals, bought the united company, and we also bought the Heisler Company, and as the owners of the gas company we are now putting in a plant to do lighting, in competition with ourselves. So that we go farther than any one who has been talking here; for not only is the gas company putting up an electric light plant when there are already other plants there, but the President of the gas company is putting in an electric light plant in opposition to an electric lighting company in which he is himself considerable of an owner. I mention this matter because in negotiating for the purchase of the property there I became familiar with some figures which show what the electric light companies have been doing. Last year one little company, with $100,000 capital (which certainly could not have had much water in it), earned a clean 20 per cent. dividend. The United Company earned 18 per cent. There were four gas companies there, and I need not tell you that they did not earn 18 nor 20 per cent. There are now five electric light companies in the city, and some of them do a very large business. The Missouri Incandescent Company (the Westinghouse System) is branching out to do an extraordinary business. The President told me the other day that they had 18,000 lights on their books. The Laclede Company is putting up a 5,000 light incandescent plant. Another company has a 2,000 to 2,500 arc light plant; and this company is also putting up a 25,000 light incandescent plant, but which is not yet in operation. In the face of all this, the

four gas organizations (which are now practically one) have had an average increase during the summer and fall thus far, of from 8 to 14 per cent., in the sale of their gas.

MR. PEARSON—How much does the electric light company which is making from 18 to 20 per cent. charge for their light? And is it an arc light company?

MR. MCMILLIN—The company that made 20 per cent. is an incandescent light company. They make private contracts, and there is no very sure way of knowing what they have charged heretofore; but they have been in competition with the gas companies, and with other electric light companies, and yet they have charged enough to get 18 or 20 per cent. out of it. Their charge depends somewhat upon the size of the customer. It is pretty cheap to hotels.

MR. PEARSON—About what is the average?

MR. MCMILLIN—Probably 75 cents per month for an incandescent light. The Arc Company charged 50 cents a light for all night lighting—for private or commercial lighting. For railroads (and they did a considerable portion of the lighting for the railroads) I believe they got $85 per year. That was not for all night, but on moonlight scale. Of course some of them burned all night, and for those they *probably* get $120, or something like that. The prices probably would be an average of the country. In this connection I want to say that I think it would be easy if all these cases of extremely low prices mentioned were investigated, to find a cause for them. I know of one town where they put in 50 lights for $48 each per year, just simply because a number of electric light companies were trying to get in there in competition, and the City Council was willing that one more company should come in. They asked for bids on 50 lights under promise to give the charter to the company that would bid the lowest. The old company bid down to $48; so none of the new companies got the contract. Of course the old company could afford to furnish those 50 lights for nothing rather than have a new company come in. I think you will find that all the extremely low prices are occasioned by something of that kind. I think that 40 or 50 cents

per light, per night—in most parts of the country—is a very good business for the electric arc light. I am like my friend Pearson, I consider that 40 cents per night for the arc light is as good as gas at say, 75 cents or $1 per thousand feet.

MR. STINESS—I move a vote of thanks to Mr. Pearson for his paper, as I consider it one of the very ablest papers we have had before our Association. [The motion prevailed.]

REPORT OF THE COMMITTEE ON PRESIDENT'S ADDRESS.

Mr. A. C. Humphreys, Chairman of Committee on President's Address, presented the following report, which was on motion of Mr. Graeff, received, and the recommendations adopted:

Your Committee to which was referred the President's Annual Address have considered the points and recommendations therein made, and would now commend to the members a careful re-reading of the address and a special consideration of the views expressed as to the conduct of the gas business so as to insure the full extension of our business.

Your Committee recommend that, following the suggestion of our President, the Council be instructed to promptly appoint a committee of seven, five of whom shall be members of the Council to represent this Association, and with the representatives of kindred Associations, to consider and take action for the proper representation of the gas industry at the Centennial Exhibition of 1892. Your Committee recommends also that the committee so appointed be authorized to officially represent the American Gas Light Association at said Exhibition, and that the actual expenses of this committee be paid from the funds of the Association under the direction and control of the Council.

Your Committee recommends that the Council be instructed to consider the question of proper co-operation between the several gas light Associations of America and take such action and make such recommendations as may by it be deemed advisable.

Your Committee recommends that the usual action be taken by the Secretary looking to the preparation of suitable minutes in reference to the members deceased during the past year.

Your Committee finally recommends that the necessary num-

ber of copies of the President's Address be printed as promptly as convenient, and two copies be mailed to each member of the Association.

ALEX. C. HUMPHREYS,
J. P. HARBISON,
J. L. HALLETT,
Committee.

THE PRESIDENT—We have time to listen to the reading of another paper before taking our recess, and I will ask Mr. Lansden to read his paper on the

ADVANTAGES OF SUPPLYING A MIXTURE OF COAL AND WATER GAS.

Mr. Lansden then read as follows:—

The subject on which I was requested to prepare a paper is "The Advantages of Supplying a Mixture of Coal and Water Gas." I did not think, when I wrote our worthy Secretary that I would furnish a short paper on this subject, that the first matter I should have to speak of, would be one of the great "disadvantages" we who are furnishing a mixed gas, labor under. It is this. We have no standard burner by which our candle power is measured. This is, of course, the most important question, when we wish to compare results. I believe there is no official recognition of any one burner in this country, for testing water, or mixed gases. Some municipalities have officially said that the gas shall be tested by a burner best adapted to the gas furnished. This leaves the question to be settled by the gas inspector of that locality.

The jet photometer, which is unreliable enough for coal gas, is vastly more so for testing water or mixed gases. Situated as we are, in Washington, we certainly have not a fair show in this regard. It is a statute law of the United States, that the Washington gas shall be tested by a fifteen hole Argand burner, which was done away with in England 16 years ago, when the 24 hole burner was adopted for testing coal gas.

Between the burner used in New York city and the one in Washington, there is something over 6½ candles. I think it unfortunate we have no recognized burner for testing water or

mixed gases in this country. In the tests I give in this paper, of candle power, I used the Bray Slit, No 7.

I will now speak of what I think are some of the advantages of supplying a mixed gas. In localities where your consumption is subject to much fluctuation, and you are supplying a straight coal gas, you are compelled to keep under fire, enough benches to furnish your greatest possible demand. When you have a water gas plant in connection, you may at all times keep your coal benches running to their utmost capacity, being able to supply your fluctuating demand from the water gas. Those only who are making coal gas know the worry and expense of half charges, idle benches, and the many changes they have to make to keep pace with dark days and rainy nights, when the moon should shine. I find our coal benches last much better and the results are much more satisfactory when we can keep them under an even fire, and doing full work all the time. This is vastly so, with recuperative benches.

One of the greatest advantages in supplying a mixed gas, is that of being able to furnish at all times any candle power required. I know it is impossible to furnish straight coal gas over 18 candle power that will give entire satisfaction to consumers. I presume that 90 per cent. of the gas consumed is burned in batswing or fishtail burners. When you go beyond 18 candle power, and often at less, consumers complain that your gas smokes. I admit much of this trouble is with the consumer. If they would keep their burners clean, we would hear less of it. This we know they will not do, and we have to accept the situation as we find it. We can give a much greater candle power with a mixed gas without smoking through the ordinary burners in use than with straight coal gas.

Right here let me say, I think the successful burner of the future will be more simple than the batswing or fishtail of the present day. If consumers will not take proper care of them, what may we expect of one that requires more attention?

In this day of electricity, we are compelled to give a much higher candle power than before its introduction. The eyes of the people have been educated to demand it, and we shall have to furnish it. This high candle power we cannot supply with straight coal gas. I do believe it would be much better for

humanity, if we could not furnish a greater candle power than 16 candles. However, the oculist and optician must live and the people must give them a chance.

There has been a great deal said about the mixing of the two gases. Some insist it will stratify in the holder. This has not been our experience in Washington. Our gases are made and purified separately. After each kind of gas has passed its meter, they are worked into one main to the gas holder. I had an opportunity this summer of testing this question of stratification. We filled a holder, while painting it, and let it stand idle for two months. When turned on to the city it was worked quite low down before more gas was put into it. We could see no difference in the gas whatever. Another advantage in making a mixed gas is, you have a much wider field from which to select your material. If the coal men pinch you in price, you can go to the oil men, and vice versa. You can feel you are not dependent on any one material from which to make your gas.

One other advantage in a mixed gas is, you reduce very materially that component of water gas, which is considered by a great many as detrimental, namely, carbonic oxide. It is certainly a great advantage when your coke yard becomes overstocked and the price not satisfactory, you can turn it into water gas.

To come at the value of a mixed gas for heating purposes, I have made a few experiments to find its comparative value. The experiments were conducted as a consumer would use the gas. I used a double ring Bunsen burner, such as is ordinarily furnished with gas cooking stoves. I used a galvanized iron tank, six inches deep, of sufficient size to hold one cubic foot of water.

I found that with a coal gas, sp. gr. 431, candle power 14.60, burning at the rate of nine cubic feet per hour, air and water 68°, the first cubic foot of gas raised the water to 78°; second to 86°; third to 94°; fourth to 102°; fifth to 110°. The five cubic feet of gas raised the water 42°, or $8\frac{4}{10}$° for each cubic foot of gas. The day following I made a similar test with coal gas, sp. gr. 445, candle power 16.12, air and water 68°. First cubic foot of gas raised the water to 76°; second to 84°; third

[redacted]

to 92°; fourth to 100°; fifth to 108°. The five cubic feet of gas raised the water 40°, or 8° to each cubic foot of gas. The ten tests of coal gas raised the water 82°, or $8\frac{20}{100}$° to each cubic foot of gas.

I followed these tests with two of carbureted water gas. The first test, sp. gr. 584, candle power, 28.10, water and air 67°. First cubic foot of gas raised the water to 76°; second to 85°; third to 94°; or 27° for three cubic feet of gas consumed —burning at the rate of nine cubic feet per hour.

The second test was water gas (carbureted), sp. gr. 578, candle power, 27.62, air 68°, water 84°. First cubic foot raised the water to 93°; second to 102°; third to 111°, or 27° for the three cubic feet of gas used. In the two tests, using six feet of gas, the water was raised 54°, or 9° for each cubic foot of gas consumed.

The average candle power of the two tests of coal gas used was 15.36; that of the carbureted water gas was 27.86, a difference of 12.50 candles; and for this difference in candle power I gained 80-100 of one degree in heating power.

The first test of mixed gases, was of one-half each. Coal gas, sp. gr. 445, candle power 16.12, and carbureted water gas, sp. gr. 567, candle power 26.90. I first half-filled the holder with the lightest gas at the top, following with the heaviest gas at the bottom. I was testing the gases on the photometer at the time I was filling the holder; so it required fifteen minutes to fill each half of the holder. I allowed the holder to remain idle for three hours, when I took the candle power and heating tests. The average candle power put into the holder was 21.51. The heaviest gas that went into the holder at the bottom as 26.90 candle power, came out 23.29. The last of the gas at the top of the holder came out 20.81. The average of the candle power that came out of the holder was 22.05, or 54-100 of a candle greater than went in. I made but two tests of the candle power of this holder; the first and last gas put in it. I desired to test the heating quality of the mixture, so I used the gas in the middle of the holder for this purpose.

As there had been, according to my test, an increase in candle power, I was not satisfied, but thought it was due to an error in my tests. I made another test three days later. The

difference in this last test from the former one was, I put the heaviest gas into the holder first, filling it half full. This gas was sp. gr. 522, candle power 23.14, (carbureted water gas). I filled the remaining half of the holder with coal gas, sp. gr. 424, candle power 14.02. This made an average candle power of 18.58. After the holder had been idle for two hours I made the following test for candle power. The first test was 16.29, second 22.22, third 21.54, fourth 21.05, fifth 21.72. The five tests taken from the holder showed an average candle power of 20.56, a difference coming out of the holder, to what went in, of 1.98 candles. This has confirmed me in the belief that mixing one-half each coal and water gas increased the candle power.

In making tests of the heating power of the mixed gas, I found they varied but very little from the value of each gas combined. For each cubic foot of gas consumed the same as the former tests, I found it raised the temperature of one cubic foot of water about 9°. Some tests gave $9\frac{14}{100}$°, others gave but 8°. I find it varied as the mixture of gas.

I made one test of water gas not carbureted. I used the same burner, but of course had to exclude the air (as we use it with carbureted gas). I burned it at the rate of 15 cubic feet per hour. During the test the air was 64°, water gas 65°, sp. gr. 485. First cubic foot of gas raised the water to 69°, second to 73°, third to 78°, fourth to 82°, fifth to 86°, sixth to 90°, seventh to 94°, eighth to 98°, ninth to 102°, tenth to 106°, or $4\frac{1}{10}$° to each cubic foot of gas consumed. Thus, uncarbureted water gas as to heating value, is but one-half that of illuminating gas. This water gas sold as a fuel gas, to do the same amount of work, will require a plant of double the size of that of illuminating gas. When it is sold at 40 cents per thousand, illuminating gas is as cheap at 80 cents, and in consequence of its odor is much safer about the house.

As this question of mixed gas is being looked into by a great many, I feel it is a matter that may interest us all. I hope others who are more able than myself may keep it before the gas associations. I do think that the most satisfactory gas of the future will be sixty per cent. of coal gas, to forty per cent. of water gas.

THE PRESIDENT—The hour for adjournment has arrived, and it will be necessary to postpone the discussion of Mr. Lansden's paper until the afternoon session.

SECOND DAY—AFTERNOON SESSION.

The association was called to order at 2 P. M.

Discussion on Mr. Lansden's Paper.

THE PRESIDENT—We will now take up the discussion on Mr. Lansden's paper on the "Advantages of Supplying a Mixture of Coal and Water Gas."

MR. ROBERT YOUNG—I would like to ask Mr. Lansden whether he made any change in the burner when he was burning 16 candle and 29 candle gas. The same burner is not suitable for both gases, and one is very apt to be led astray and to think that the 16 candle gas has about as high heating power as the 27 candle. I think the burner was at fault.

MR. LANSDEN—I used the same burner.

MR. A. C. HUMPHREYS—I would like to say a word on the subject of stratification. To my mind it could be covered in this way, that if you give the gases a chance to mix they will mix completely. I think the idea that gases will stratify is entirely erroneous, but if you give gases a proper chance they will thoroughly mix. It will not do to say, on the other hand, that gases will not stratify in the ordinary acceptation of the term, because if you do not give them a chance to mix they will come out stratified to the consumer, but if you give them a chance to mix in the holder the mixture will go complete to the consumer. As to another point with regard to the mixture of gases by means of an exhauster, I would like to point out that of course it is not necessary to have any elaborate system of double purification after mixing. We could of course bring those gases together by the use of only one exhauster, and still mix in any required quantity of water gas with coal gas or

vice versa, by the use of one exhauster and one holder. We are constantly doing that.

The President—Would there be any special objection, provided the two gases were of equal candle power, if they were not thoroughly mixed?

Mr. A. C. Humphreys—Yes; there would be. The same burner would not be adapted to the two gases, and you get unequal results. The gases ought to be mixed.

Mr. Robert Young—I quite agree with Mr. Lansden, about the effect of using mixed gas. We use in Allegheny (where we have both processes) a water gas plant and a coal gas plant, and of course are mixing our gases all the time. The mixture of water gas to coal gas ranges from 25 to 75 per cent. Ours is not a water gas exactly but a mixture of 66.66 per cent. of water gas and 33.34 per cent. of natural gas—in summer we make 75 per cent. of this mixture and 25 per cent. of coal gas and in winter it is just reversed; taking the whole year we make 50 per cent. of each. As far as the stratifying of the gas is concerned we have no trouble with that. I also agree with Mr. Lansden that we make a better gas and a gas that is more satisfactory to the people than we did when we made a 16-candle coal gas. Our mixture of gas averages from 18.56 to 19 candle power. Since we have been using water gas we have never had a single complaint from the people of smoked ceilings. Before that we tried to increase our illuminating power by injecting oil into the retorts, but if we thus increased the illuminating power to 18 or 20 candles the next thing we heard was about its discoloring the wall and ceilings. Since we have used the water gas, mixing it with the coal gas, we have never had a bit of trouble.

Mr. Cowdery—I have tried the same experiment that Mr. Lansden speaks of, and found the results to be very close to what he has stated.

On motion of Mr. Walton Clark, the thanks of the Association were voted to Mr. Lansden, for his paper.

The President—We will next listen to the reading of the paper by Prof. E. G. Love, on

GAS CALORIMETRY.

PROF. LOVE.—Perhaps I should state, before commencing my paper, that the reason why there are no copies printed is due to my ignorance of the custom of the Association—a praiseworthy one—of having the papers printed in time to put them in the hands of the members at the meeting. I was not aware of that custom, and consequently did not send my paper to the Secretary in time to have it printed.

The constantly increasing demand on the part of the public for some cheap and efficient gaseous fuel naturally renders this one of the most important questions which engage the attention of a body of gas engineers.

The number and scope of the papers on gaseous fuel which from time to time have been brought before this Association render anything I might say from a strictly engineer's standpoint quite unnecessary. And yet as the efficiency of a gaseous fuel is quite as important as its cheapness, it has occurred to me that perhaps a few words on the practical determination of the heating power of gas might not be without some interest to the Association.

The object of calorimetry is to measure the quantity of heat which is produced or absorbed during any chemical or physical change; and a calorimeter is an instrument employed in measuring this heat. This includes the determination of specific heat, latent heat, heat of combustion, etc., and, consequently, the form of calorimeter must depend upon the nature of the investigation.

At present we have to do with the determination of the heat of combustion, and this is more especially as it relates to gaseous fuels.

The calorific power of a fuel may be defined as the total quantity of heat produced by the combustion of any given quantity of it. This power depends not only upon the chemical composition of the body, but also on certain chemical and physical properties. Thus the calorific power of carbon in the form of wood-charcoal would be represented by the number 8,080, while in the form of the diamond it would be 7,770.

It is important to distinguish between *calorific power* and *cal-*

orific intensity. The first has to do solely with the quantity of heat produced, and would be the same whether the combustion took place in the oxygen gas or in the air. A piece of wood produces the same quantity of heat when allowed to decay in nature as when burned in a stove, but the calorific intensity is entirely different.

The calorific intensity, then, refers not to the quantity of heat, but to the temperature produced, and it is sometimes defined as the temperature to which the burning of any substance will heat the products of its own combustion. While the quantity of heat is the same whether the fuel is burned in oxygen or in air, the calorific intensity or flame temperature would be very different. When burned in the necessary quantity of oxygen, the heat produced raises the temperature of the products of combustion only, but when burned in air the heat must raise the temperature of the nitrogen present in addition to that of the products of combustion, and consequently the temperature reached is not so high. When, as in practice, the air is, and must be in considerable excess, the flame temperature is even lower. As an illustration, a given weight of carbon when burned in the requisite amount of oxygen will give a temperature of 10,174° C.; when burned with just enough air to furnish the necessary oxygen, the temperature is lowered to 2,715° C.; and, lastly, when the amount of air is twice that necessary to furnish the oxygen, the temperature is only 1,408° C. With hydrogen these figures would be 6,930° C., 2,741° C., and 1,550° C.

In measuring calorific power reference is made to water as a standard, and a heat unit is the quantity of heat required to raise a given quantity of water 1 deg. in temperature.

Unfortunately some confusion exists from a lack of uniformity in the heat unit employed by different writers. In England and in this country the unit is either the pound Centigrade or the pound Fahrenheit. The pound Cent. unit is the quantity of heat required to raise the temperature of one pound of water 1 deg. C., while the pound Fahr. unit differs only in substituting the Fahr. degree for the Centigrade degree. Since 1 deg. on the Cent. scale is equal to $\frac{9}{5}$ deg. on the Fahr., the expression of calorific powers in the pound Cent. unit is converted into pound Fahr. unit by multiplying by $\frac{9}{5}$. The reverse calculation is made by multiplying by $\frac{5}{9}$.

The French unit, generally employed in France and Germany, is the quantity of heat required to raise the temperature of 1 kilogram of water 1 deg. C. It is called a calorie, and is equivalent to 2.2 pound Cent. units, or 3.96 pound Fahr. units.

The method of arriving at the heating power of any fuel by a calculation based upon certain generally accepted data may be relied upon in some cases, and yet, to a practical man, that method will naturally commend itself which determines the heating power by actual experiment.

For solid and liquid fuels a calculation gives only rough approximations to the truth, and this must continue to be the case so long as our knowledge of the constitution of the carbon and hydrogen in these fuels remains in its present imperfect state. To calculate the heating power of a sample of coal from the amount of carbon and hydrogen it contained, and the calorific values usually assigned to these elements, would be assuming that the carbon of the coal had the same heating power that it has in wood charcoal, and that the hydrogen had the same value as experiment has shown it to have in its elementary, gaseous condition. Some improvement is made when we recognize the probability, suggested by M. Cornut, that the fixed and volatile carbon have different calorific powers; and still we are very much in the dark.

With liquid fuels the data upon which to base a calculation of their calorific powers is as uncertain as with solid fuels.

In the case of gaseous fuel a calculation becomes more reliable since there is less uncertainty in the data upon which it is based. Two methods have been employed for calculating the calorific power of a gaseous fuel. The first considers the gas as containing known quantities of carbon and hydrogen, and its calorific power is calculated on the assumption that these constituents have the same calorific value as though in their elementary condition. This is open to the same objection noticed in the case of solid and liquid fuels; and the result based upon it is, therefore, erroneous.

The other method considers the gas as a mixture of hydrogen, marsh gas, olefiant gas, carbonic oxide, etc., for each of which a calorific value has been experimentally determined. If the percentage by weight of each of these constituents be mul-

tiplied into its calorific power, the sum of the products thus obtained will equal the calorific power per pound of gas. This gives us the most reliable result which it is possible to obtain by calculation. It involves a complete analysis of the gas in question, and, moreover, the nature and amounts of what are usually designated as "illuminants" or heavy hydro-carbons must be ascertained, since the constituents of the illuminants have different calorific values; thus it is that an actual laboratory test, while it may not be fully realized in the practical use of a gaseous fuel, is at once a more expeditious and satisfactory method of reaching the desired result.

In order to illustrate more in detail the methods employed in determining the heating power of gas I have sketched here three calorimeters suitable for such determinations. The first is that of Andrews (see Fig. 4.) which involves the explosion of the gaseous mixture in a closed copper vessel. It consists

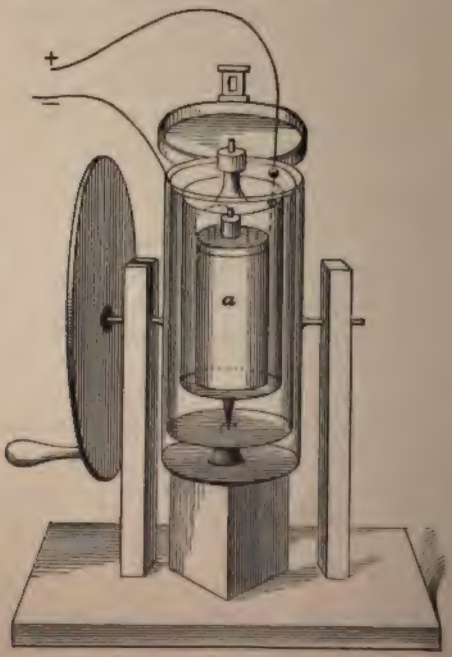

FIG. 4.

of four cylinders, one within another. The gas to be examined, mixed with the requisite amount of oxygen, is inclosed in the vessel A, which is placed in a larger vessel filled with water. This is itself placed in a cylinder provided with a cover, and the whole enclosed in an outer vessel arranged to rotate on a horizontal axis. The apparatus is first rotated to establish uniformity of temperature, this temperature being then measured by a delicate thermometer. By means of the wires shown, a current of electricity is passed through a fine platinum wire, placed in the gaseous mixture, until the wire becomes sufficiently heated to explode the gas. The calorimeter is then closed and rotated for 35 seconds to distribute the heat through the apparatus.

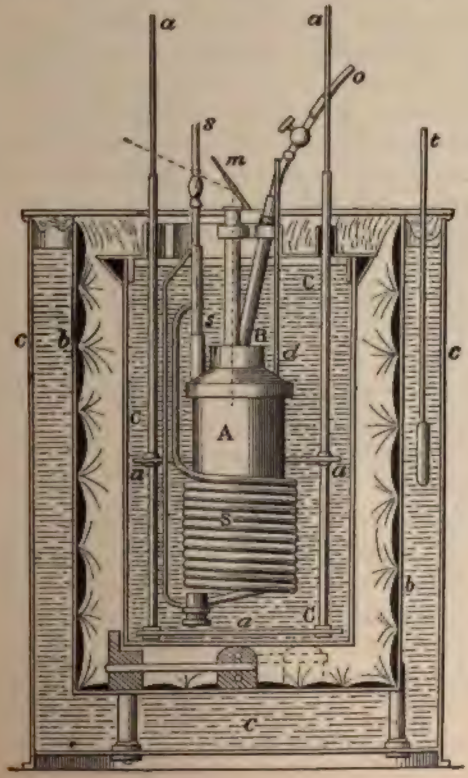

FIG. 5.

The thermometer is again introduced and the increase of temperature observed. This, together with the known calorific capacity of the apparatus, furnishes the necessary data for calculating the calorific power of the gas.

The second calorimeter is that of Favre and Silbermann (see Fig. 5.) It is so arranged that the fuel can be burned in oxygen gas. It consists of the combustion chamber A, made of gilt copper plate. Surrounding this is the vessel C C C, which is filled with the water to be heated. Outside of C C is the vessel of silvered copper *b*, the space between this and C being filled with swan's down. The whole is contained in the vessel *c c* to the bottom of which *b* is firmly fastened. The annular space between *b* and *c* is filled with water, the temperature of which is indicated by the thermometer *t*, and which serves to neutralize any accidental variations in the temperature of the atmosphere. The tube *d* serves to convey the purified oxygen into the calorimeter, and when the substance to be tested is a gas, it is introduced by the tube *o*. The gaseous products of combustion escape by the tube *s*, pass through the coil S, where they communicate their heat to the surrounding water, and finally leave the instrument by the upper part of *s*. *a a* is a mechanical agitator, and *m* a mirror which enables the operator to observe the progress of the combustion, the opening into the calorimeter being closed by a triple disc of glass, alum and quartz. In all cases where it was practicable to do so, Favre and Silbermann calculated the quantity of substance burned from the weight of the products of combustion.

The calorimeter to which I wish especially to call your attention, is one devised by the late Mr. F. W. Hartley (See Fig. 6.) It consists of the water cistern, A, provided with a ball-cock, and connected with a larger cistern or supply ; B, the outlet of the cistern, is a glass tube containing a thermometer for ascertaining the temperature of the inlet water; C, is a water jacket surrounding the Bunsen burner; D, is the body or calorimeter proper, consisting of a modified Coffey's still, which presents internally a large wetted surface for the absorption of heat; E, is a box to contain an anemometer when desired; F, is a copper chimney, and G is a ring-burner for heating the upper part of the chimney—this is necessary, inasmuch as the products of

combustion, being below the temperature of the air, cannot produce the necessary draught. M, is the meter delivering 1-20 cubic foot of gas per revolution, and R, is a sensitive governor placed on the outlet of the meter. Delicate thermometers are employed to determine the temperatures of the atmosphere, the inlet water, the outlet water, the body of the calorimeter, the products of combustion and the gas tested.

In working, the gas passes from the cistern, through the tube, B, and the jacket, C, to the upper part of the body, D, through which it descends, finding an exit through the lip into the collecting cistern, J. The gas is burned at the rate somewhat less than 1½ cubic feet per hour, while the quantity burned in each test is ¼ cubic foot. With our gases of higher candle power I find that the consumption cannot much exceed 1 foot per hour, the experiment lasting about fifteen minutes. The gas and

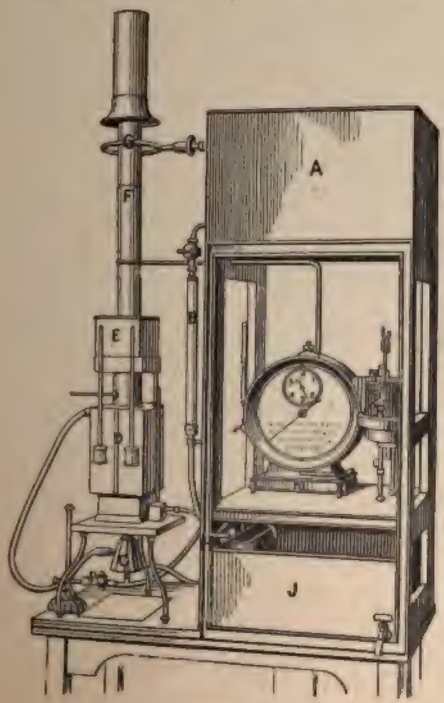

Fig. 6.

water supplies are first regulated so that the increase of temperature shall be from about 5 to 8 deg. Fahr., the water meantime running to waste. After this adjustment is made and the readings of the thermometer are tolerably uniform, the index of the meter is taken and the outlet water turned into the collecting cistern. During the test the thermometer indicating the temperature of the heated water should be read frequently. My practice is to read this thermometer four times during each revolution of the meter, making 20 readings during the test. Each of the other thermometers is read five times at regular intervals. When the .25 cubic foot of gas has been consumed the water is turned to "waste," the time is noted and the water in the collecting cistern either weighed or measured and the weight calculated. The weight of water in pounds multiplied by the increase in temperature of the water and divided by the corrected volume of gas burned, gives the calorific power per foot of gas. The results obtained with any calorimeter require some correction, the nature and extent of which vary with the different forms of instruments. This is usually determined once for all. Mr. Hartley pointed out the following possible sources of error in his calorimeter:

1. Absorption of heat by the *body* of the instrument, and loss of heat by the heated water *receiver*. Exeriments have shown that for each degree Fahr. which the body of the calorimeter is below the temperature of the air, it absorbs an amount of heat equal to .025 of a unit per minute, and that for each degree which the receiver—and issuing water—is above the temperature of the air it loses .01 of a unit per minute. If, therefore, an experiment lasted ten minutes and the body was 5° Fahr. lower than, and the receiver 5° Fahr. above the temperature of the air, the corrections would be:

$.025 \times 5 \times 10 = 1.25$ gain, to be subtracted.
$.010 \times 5 \times 10 = \ .50$ loss, to be added.

.75 unit gain, to be subtracted from the result for ¼ foot consumption.

2. Absorption of heat from the air supplied to the burner, and aspirated through the apparatus. From various tests Hartley became satisfied that not more than 13 feet or, say, one

pound of air, passes for each foot of gas burned. On this basis, if the effluent gases were 3° Fahr. below the air the correction per cubic foot of gas units would be .2379 (specific heat of air; Regnault) multiplied by 3=0.7137 unit. No correction is made for this small error.

3. Differences in the specific heat of water at different temperatures.

Regnault found the specific heat of water

at 86° Fahr. . .	1.0020
at 50° Fahr. . .	1.0005
	0.0015, or 15 units in 1000;

equal to .04 of a unit in 1000 for each degree between 50° and 86°. If 620 units of heat were realized per cubic foot of gas with water at any temperature between 50° and 86° the correction would be 620x.04÷1000=0.025 of a unit to add.

No correction is made for this

4. Radiation downwards from the burner. The burner is of the Bunsen type and radiation is not great. Moreover, the flame is wholly within the body, and any radiated heat for the most part falls upon the water-jacket placed around the burner tube. The loss, therefore, by radiation is practically nothing.

As to the efficiency of this instrument, I have not tested it as yet with any simple gas of known calorific power, but I may state that a test with hydrogen by Mr. Hartley gave 329.28 heat units per cubic foot at 60 deg. Fahr. and 30 in. This is equivalent to 620.80 heat units per pound.

Appendix.

Memoranda of Calorific Test of Gas.

Temperature of air . . .	69.28° F.
" " water-inlet, below air	3.767°
" " " outlet, above air	4.413°
" " " raised . .	8.180°
" " escaping gas . .	68.00 °
" " body . . .	67.852°
" " gas . . .	69.00 °

Duration of test . . . . . 15.033 Min.
Gas burned . . . . . . 0.25 cu. ft.
" " corrected to 60° and 30 in. .24515 ft.
Lbs. of water heated . . . 20.814

Correction:

$1.428 \times .0258 \times 15.033 = .554$ gain.
$4.413 \times .01 \quad \times 15.033 = .663$ loss.

$.109$ unit loss.

$20.814 \times 8.18 = 170.25 + .11 = 170.36 \div .24515 = 694.92$ heat units at 60° and 30 in.

Candle power 21.94.

Table of the Calorific Powers of Gases, based on the Results of Prof. Julius Thomsen.

GAS.	Formula.	Specific Gravity Air-1.	Weight of 1 cu. ft. Grains.	Number of cu. ft. in 1 lb.	Calorific Powers, Lb. Fah. Units. Water—Liquid. Per lb.	Water—Liquid. Cu. ft.	Water—Vapor. Per lb.	Water—Vapor. Cu. ft.
Hydrogen.	H	0 0693	37.04	188 98	61524.0	325.5	51804.0	274.1
Mathane or Marsh Gas ..	CH_4	0 5576	298.03	23 49	24022.0	1022.8	21592.0	919.3
Ethane	C_2H_6	1 0374	554 48	12 52	22399.8	1774.3	20455.8	1620 3
Propane..... .	C_3H_8	1 5246	804.89	8.59	21825.0	2540.7	20057.7	2335.0
Ethylene	C_2H_4	0.9784	522.95	13.38	21522.8	1607.9	20134.3	1504 2
Propylene	C_3H_6	1 4980	800 67	8 74	21222.8	2427.5	19834.2	2268.7
Acetylene	C_2H_2	0 9100	486 39	14 39	21492.7	1493.4	20745.0	1441.4
Benzene Vapor	C_6H_6	2.7000	1443.14	4 85	18183.4	3748.7	17435.7	3594 6
Carbonic Oxide.	C O	0 9677	517 23	13.53	4395.2	324.7	4395.2	324.7

I have calculated the weight of 1 cubic foot of air at 60° F. and 30 in. pressure as 534.495 grains.

Discussion.

The President—This is a very interesting paper, and I have no doubt that the Professor will be glad to answer any questions you may ask him.

Mr. Jones—I would like to ask if it is true that the calorific power of carbonic oxide, when burned with oxygen, is greater than that of hydrogen when burned with oxygen, foot for foot.

Prof. Love—According to the figures that I have here, it makes no difference, so far as calorific power is concerned,

whether the gas is burned in oxygen or in air. The quantity of heat is the same, but the intensity would be different. I have calculated the calorific power of hydrogen as 325.5 heat units per cubic foot, and that of carbonic oxide as 324.7 units. These figures suppose the aqueous vapor produced in the burning of hydrogen to have been condensed, and its latent heat rendered sensible.

MR. NORRIS—Then the comparison between carbonic oxide and hydrogen is affected by the condensation of the watery vapor, and also by the temperature at which the gases are discharged. I believe that carbonic oxide takes about 2½ times as much oxygen to burn it as hydrogen, and, therefore, if you discharge the products of combustion at 600 deg. you lose more carbonic oxide than you do of hydrogen.

PROF. LOVE—These figures are based upon the supposition that the gaseous products are deprived of their heat. Of course it is important in any calculation of this sort to do that, or the figures would be quite different. In the case of hydrogen you have steam produced which goes off as vapor, carrying with it all the latent heat. These calculations are based upon the supposition that the aqueous vapor is condensed, and that the latent heat becomes sensible and is measured. When the vapor is not condensed, the calorific powers become 274.1 units for hydrogen and 324.7 units for carbonic oxide.

MR. NORRIS—I meant marsh gas and not carbonic oxide.

MR. JOHN YOUNG—I would like to ask Prof. Love in what way he obtains the results when he is testing different gases. For instance, light carbureted hydrogen would require a much larger quantity of air for combustion than would hydrogen.

PROF. LOVE—The burner employed is so constructed as to allow an adjustment of the air supply to the gas burned.

MR. JOHN YOUNG—Would there not be a liability to error on account of imperfect combustion?

PROF. LOVE—I think not, and still if the combustion were imperfect an error would of course be introduced. In order to insure against this the products of combustion should be ex-

amined. A glass tube can be inserted into the escape pipe, and the products of combustion drawn off and analyzed. If the analysis showed that the carbon had been burned to carbonic acid, and that no carbonic oxide were present we should conclude that the combustion had been perfect. It may be safely assumed that the same proportions of the gas and air would produce perfect combustion under practically the same conditions.

MR. NETTLETON—Before leaving Prof. Love's paper I would like to ask him a question. He has tested both water and coal gas; but I would like to ask him if he has ever tested a mixture or combination of water and coal gas; and, if so, if he has found that the result is the average candle power of the two gases—the theoretical candle power—or, if it is higher, how he explains that fact. Probably he is in a better position to make that test than any one else in the room.

PROF. LOVE—I have not made a sufficient number of tests on that particular point to answer your question. I may say that at my laboratories it is now impossible for me to get any pure coal gas, for the reason that, since the consolidation, it is mixed with water gas, and the only way is to bring the gas to my laboratory, or take my calorimeter to the gas works. At the Manhattan works they make pure coal gas, but in distribution it is mixed with water gas, so that I can never tell exactly what I am getting. I have determined the calorific power of that mixture, which contains about 50 per cent. of water gas. Of the water gas I have determined the heating power a great many times, but not of pure coal gas.

MR. NETTLETON—My question is as to the candle power. If you take coal gas of 18 candle power and water gas at 20 candle power, theoretically, the mixture should be 19 candle power; but, practically, it is stated to be above 19. Has Prof. Love found it so in his experience?

PROF. LOVE—I misunderstood your question. I have not made that test and cannot say how it would be.

MR. NORRIS—How would it be with regard to the quantity of air?

PROF. LOVE—The latent heat would become a factor in the case of marsh gas and hydrogen, but not in the case of carbonic oxide.

MR. GLASGOW—In the Favre and Silbermann instrument does it discharge the products of combustion at a temperature lower than the surrounding atmosphere?

PROF. LOVE—No; they cannot be lower than the temperature of the water, which is practically the temperature of the air, and corrections have to be made for every calorimeter.

On motion of Mr. A. C. Humphreys, the thanks of the Association were voted to Prof. Love for his valuable paper.

REPORT OF COMMITTEE ON PLACE OF NEXT MEETING.

MR. BOARDMAN—Your Committee has considered the place for the next meeting, and from the composition of the Committee it seems to us that it would be very desirable to have the Association make a trip to the sunny South. We have thought that many of our beautiful cities would like to entertain us, but we have at last come to the unanimous conclusion that Savannah, Georgia, would be the best place at which to hold the next meeting. (Applause.) In addition to the well-known hospitality of the South, we had the pleasure of receiving the following communications, which in a measure determined the exact location:

"*To the Committee on the Selection of a Place for the Next Meeting:*

"*Gentlemen:*—Learning that your Committee is thinking of selecting some Southern city for the next convention of our Association, I wish to extend to the Association, in the name of the United Gas Improvement Company, a hearty welcome to any city in the South where that Company is in control of the gas interest. I would especially mention Atlanta, Savannah and St. Augustine.

Very respectfully yours,

ALEXANDER C. HUMPHREYS,

For the United Gas Improvement Co."

In selecting this place we wish to extend our thanks, and I am sure also the thanks of the Association, for the hearty welcome extended by the United Gas Improvement Company.

On motion of Mr. Denniston the report of the Committee was received, and the selection of the place for holding the next meeting of the Association, approved.

Committee of Arrangements.

The President appointed as a Committee of Arrangements for the next annual meeting: Alexander C. Humphreys, Philadelphia, Pa.; A. E. Boardman, Macon, Ga.; Thomas Turner, Charleston, S. C.; David Douglas, Atlanta, Ga.; W. G. Abel, Atlanta, Ga.

The President—The next paper read will be that by Mr. Frederick H. Shelton, on

ILLUMINATING WATER GAS—PAST AND PRESENT.

Mr. President and Members of the American Gas Light Association:

In presenting for your consideration a paper upon water gas—a subject that has probably excited more discussion and more controversy than any other one topic in the gas industry—it is, perhaps, well for me, at the outset, to briefly give my reasons for so doing.

To my mind, the present time marks a well defined and well rounded out period in water gas history. Known as a gas in the chemist's laboratory a hundred years ago; struggling through the early stages of experiment; striven after by gas men and inventors throughout the century; frowned upon as illegitimate and with many an effort to throttle it by the older gas interests, water gas, like a lusty child, has steadily grown to be a stout, fighting competitor of, even threatening to outstrip, these older forms of gas manufacture, and has developed into a well-recognized and legitimate position in the gas industry.

Innumerable patents and methods for its manufacture have appeared, risen to a brief zenith of fame, and disappeared,

until, as in the survival of the fittest, a well defined and commercially successful system of manufacture has been evolved. In this process of evolution, water gas has spread throughout the land, far more than I think most of us appreciate--and it is my intention in this paper to show you somewhat the extent of this growth, especially within the last 15 years; and, also, to give you a brief review of the early state of the art, together with a *resumé*, of the practical methods for its manufacture to-day.

The Earlier History of Water Gas.—It is most interesting to note that the discovery of water gas, as a gas, dates back to a time when the composition and nature of gases in general was but little known. Hydrogen was known as "inflammable air," and when (in 1784) Cavendish made the discovery that it was one of the components of water, it was looked upon with great astonishment. Four years before this, however, one Fontana had called attention to the reaction which takes place between steam and incandescent carbon, at high temperatures, which, as you all know, is the basis of the whole theory and chemistry of water gas.

In "King's Treatise on Coal Gas" we find that Lavoisier and Meusnier, prominent chemists of that day, in investigating the composition of water, by analysis, "passed steam through a red hot pipe, whereby they obtained a quantity of 'inflammable air' which, when mixed with atmospheric air, or oxygen, exploded upon being ignited. They afterwards introduced charcoal in the pipe, which resulted in a considerable increase in the quantity of the gas, although of a somewhat different nature. This, then, was the first production of water gas." This period was practically contemporaneous with the earliest utilization of coal gas; for about 1793—eight years later—we find Wm. Murdoch, the universally acknowledged "father of gas lighting," "distilling the vapors from bituminous coals," and applying them to the lighting of his house.

The first one who appears to have attempted to apply Fontana's observations, and the theory of water gas, to practical gas making, was one Ibbetson who, in 1824, in England, made a water gas by passing steam through a mass of incandescent car-

bon. From this date down to, say, 1858, inventions succeeded one another in great rapidity—no less than sixty patents appearing within this period, all aiming to take advantage of the reaction of steam and carbon at high temperatures. In theory, water gas was recognized, and its desirability admitted, but in practice, in all this period, no commercially successful system of manufacture was hit upon. I will not tire you with a detailed list of these patents, for most of them failed to get beyond the patent office. Those who are interested can find them listed in the *American Gas Light Journal* for September 16, 1864.

Some few of these patents are worthy of note, however, from the fact that they contain some one or two of the essential features of the modern water gas apparatus; and it was precisely the combination of these individual features that has produced the successful systems of to-day. For instance, in 1831, George Lowe patented a simple generator, for the express purpose of utilizing the hot coke drawn from retorts. The combustion of the coke was obtained by natural draft, instead of the modern forced blast; when a proper heat was obtained steam was admitted, decomposed, led off, and afterwards carbureted. Except in the matter of draft, mark the similarity to the modern Tessie du Motay system.

In 1832, M. Jobard, of Brussels, erected plants for supplying Dijon, Strasburg and Antwerp, and part of Paris, with "water gas impregnated with hydro-carbon vapors."

In 1839, George Cruikshank makes water gas in vertical retorts filled with carbon, and fired externally, a forerunner of the modern Allen-Harris type.

In 1847, Stephen White devised a somewhat similar apparatus, which met for a time with some little success, plants being erected at Ruthin, Southport, Warminster, Dunkeld, etc., and exciting some little comment in English gas circles. A good description of his method may be found in "Hughes on Coal Gas," edition of 1853.

In 1852, the Kirkham Bros. designed a furnace, or generator, to be "blown up" continuously, with the admission of a steam jet. The producer gas so formed was afterwards carbureted; and in this we have the forerunner of the modern McKenzie method.

In 1856, the system of M. Gilliard appears. This was simply the injecting of steam in a retort, containing incandescent carbon, and the pure hydrogen gas thus formed was used for light, through the medium of a platinum burner, heated to incandescence; the forerunner, again, of the modern incandescent gas lighting systems. Extensive works of this type were erected at Narbonne and Passy, France, a description of which can be found in the *American Gas Light Journal* for October 15, 1860.

In 1856, also, Frederick Siemens invents the regenerative furnace, or the chamber filled with loose fire brick, for the storage up of heat from waste gases, which has since become so essential a feature of metallurgical furnaces, and which, under the name of superheater, and used as a fixing chamber, plays so important a part in most of the modern successful water gas apparatus.

Most of the patents up to this date were in England and France, and it is not until 1858 that we find record of water gas plants, of any note, erected in America.

Just at this point—as we take up the list of water gas processes that have since appeared in America—I would call your attention to an important distinction, which I would have you bear in mind, viz.: the two general classes into which all water gas apparatus can be divided.

Class I, Retort Processes, or "those in which steam is admitted into retorts containing carbon, the temperature of which is maintained by combustion *external* to the retorts;" and

Class II, Generator Processes, or, "those in which steam is admitted into retorts or furnaces (generators) containing carbon which has been previously heated by partial combustion of its own mass, or by *internal* combustion."

I would here state that in enumerating the various processes and apparatus, both in this class and the succeeding, I do not propose to attempt to list all of the several hundred water gas patents that have been taken out, but simply to give a *resumé*, as far as I am able, of the forms of apparatus of which plants have actually been erected, and put to practical use.

We have in Class 1, Retort Processes:

1st. The Sanders apparatus.

2d. The (Gwynne, or) Allen-Harris apparatus.

3d. The Salisbury (or Slade) apparatus.
4th. The Jerzmanowski ("Boot-leg," or Baby) apparatus.

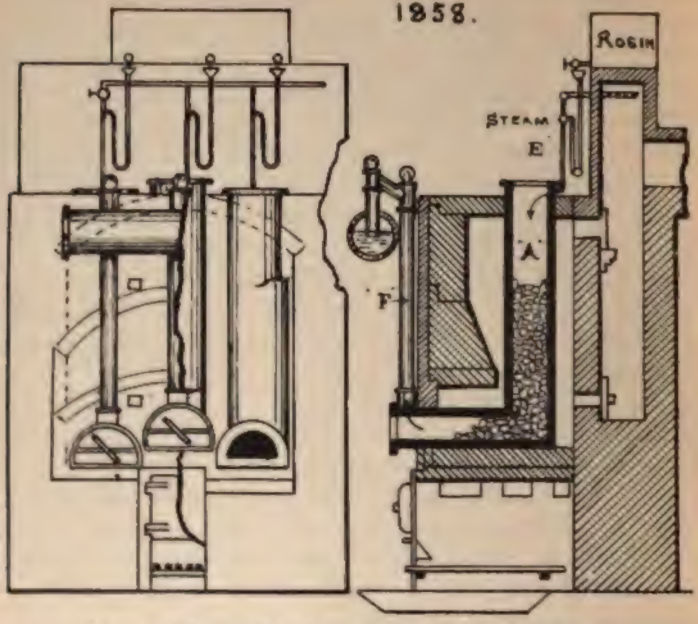

FIG. 7.—WATER GAS APPARATUS OF J. M. SANDERS.

The Sanders Apparatus:—In Fig. 7, I show a sketch of the first water gas plant of which I can find any record, as having been erected in the United States, and which illustrates the method of manufacture of Dr. J. Milton Sanders. In this, the "L" shaped cast iron retort "A," set in an ordinary bench furnace, was charged with charcoal and brought to a high heat. Superheated steam was then admitted at the top at "E," and passing downwards, was decomposed and, uniting with the carbon from the charcoal, formed a non-luminous water gas. At the same time melted rosin was introduced in the retort for enriching, and the mixture passed out the standpipe "F," to hydraulic main, etc. You will see that there was almost no "fixing" of the gas, and this fact, together with the resulting condensation, and the excessive wear of cast iron retorts (owing to the high heats necessary for the decomposition of the steam),

practically killed the system. It is interesting, however, to note the interest it excited. During the years 1859 and 1860, plants were erected in Philadelphia, at the Girard House; in Wilmington, Del.; Aurora, Ind.; Laconia, N. H., etc. Extravagant claims were made, and the columns of the *American Gas Light Journal* at that period were filled with arguments respecting the merits of the apparatus. In fact, any one desiring a highly respectable water gas controversy need but go back thirty years, take this case in toto and change but the names and dates.

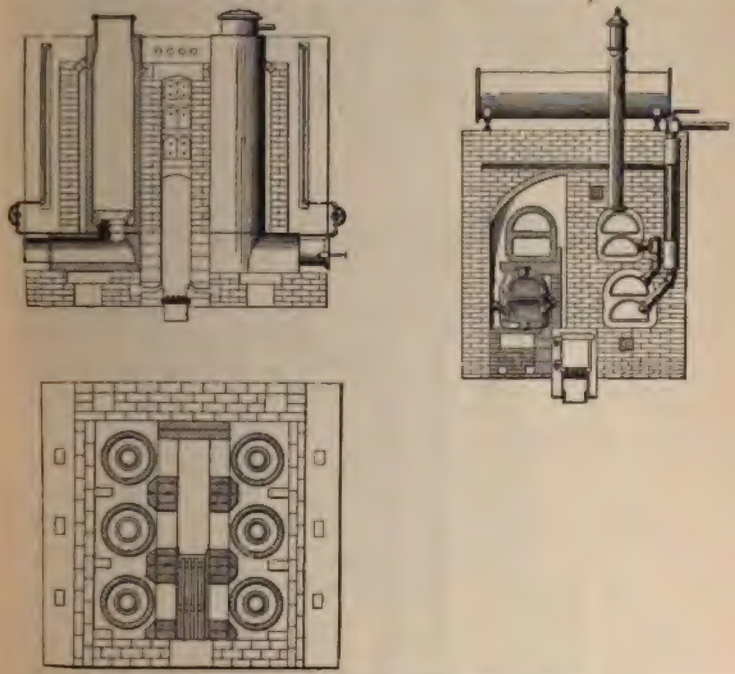

FIG. 8.—THE ALLEN-HARRIS APPARATUS.

The Allen-Harris Apparatus:—The second method to excite general interest in gas circles was the "Gwynne-Harris," or "American Hydro-carbon Process," as it was then frequently called. Mr. W. A. Gwynne, after taking out several patents, dating from 1863, and erecting a plant at Elizabeth, N. J., which was in operation for several years, became associated with Mr. G. W. Harris, also controlling several water gas patents, and

together they erected at Fair Haven, near New Haven, Conn., in 1868, the first plant under the "Gwynne-Harris" system.

It excited much interest, was visited by many prominent gas men, and was the subject of five months' experiment and an exhaustive report of two hundred pages, by Professors Silliman and Wurtz, in 1869, which report was afterwards published, and can be found in the *American Gas Light Journal* through the year 1874. Some time before this Mr. Gwynne died, and the "National Coal Gas Co." being formed, with Messrs. H. P. and A. L. Allen, at its head, the name gradually changed to "Allen-Harris," by which it has since been known.

This system was almost the only one that occupied public attention in the Water Gas line from 1868 until the advent of the generator processes in 1875.

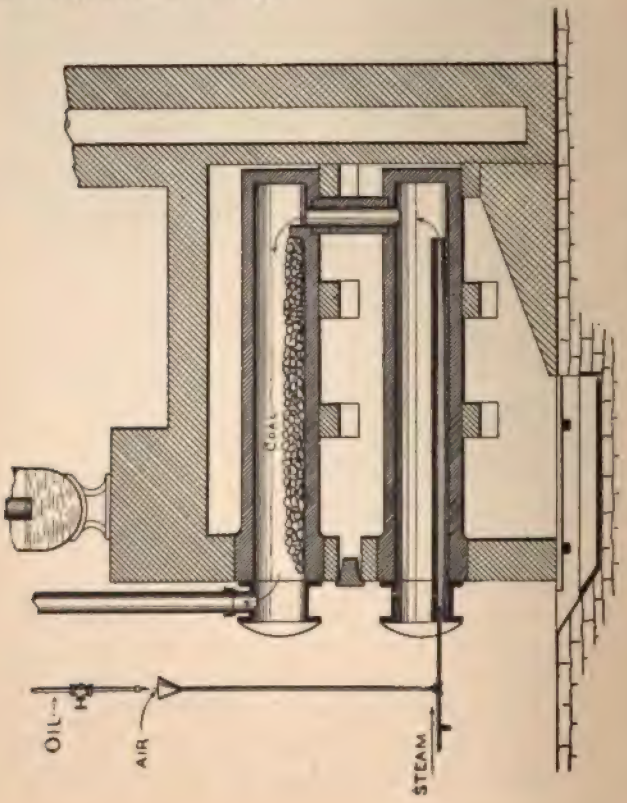

Fig. 9.—The Salisbury Apparatus.

Its backers stoutly took up the cudgels for water gas, writing column after column in its favor, and installed plants at Utica, Brooklyn and Westchester, N. Y.; Newark, N. J., etc., all of which were operated for a longer or shorter period.

Since that time, numerous patents for improvements have been taken out, and the apparatus introduced at Rondout and Poughkeepsie, N. Y. As one of the best developed of retort processes, it may be of interest to note Fig. 8, which shows the apparatus erected in 1884, at Poughkeepsie.

In this, "A" is a bench of vertical fire clay retorts. Each retort is filled with carbon, and steam, admitted at the top in finely divided jets, in passing down through, is decomposed; the gas so formed then passes to the bench of horizontal double retorts "B." "Oil C," for enriching, and the water gas "D" unite and pass into the lower chamber of the lower retort, and thence through 36 feet of increasing heats, to the standpipe.

The Salisbury Apparatus:—There have been numerous attempts by coal gas engineers to produce water gas in existing benches and retorts. These have resulted in many combinations of retorts, with the introduction of steam jets and hydrocarbon vapors, few of which have ever attained the dignity of a "process," or been heard of beyond the works of the inventor. It is manifestly impossible to herein describe all these efforts, and I will content myself with one, which is probably as typical and effective as any, and shown in Fig. 9.

The "Salisbury," or, perhaps, more properly speaking, the "Slade" method, as in operation at Yonkers, N. Y, for six years, consisted of the introduction of a jet of superheated steam, carrying a fine stream of naphtha through the mouthpiece of and into a retort, in an ordinary bench setting. This stream of steam and oil vapor was then carried through a fire clay pipe on the bottom of the red hot retort to the rear end, where, issuing from the pipe, it expanded into the upper part of the retort, and passed forward and out of the standpipe. One or two retorts were used for the regular coal gas, to supply coke for firing the bench, and a later modification of the method was to pass the water gas from the lower retort up to and through the coal gas retort above. Although not so intended, as arranged at Yonkers, air was drawn in with the oil into retorts,

resulting in a partial internal combustion, and adding a certain percentage of nitrogen to the gas.

The chief claims made for this method of manufacture were: low cost of equipment; high candle power of gas; and the usual "general economy." It is worthy of note, however, that it has since been superseded by a much more typical and effective water gas apparatus.

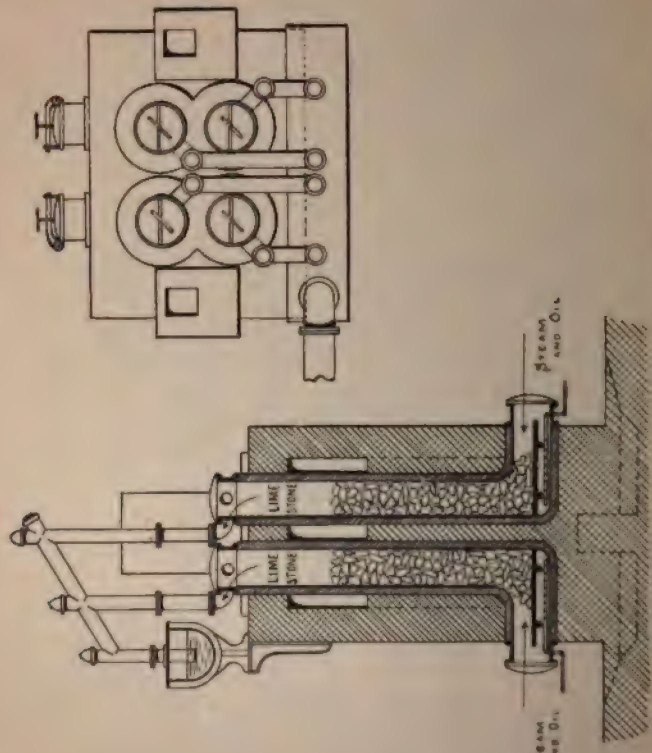

FIG. 10.—THE JERZMANOWSKI "BOOT-LEG" OR "BABY" APPARATUS.

The Jerzmanowski "Baby" Apparatus:—This form of apparatus, dating from 1886, consists of "L" shaped retorts (see Fig. 10), in the usual bench setting, the chief peculiarity of which is that the vertical portion of each retort is filled with "hard burned lime," or limestone, which is maintained at a red heat. Steam injected, as usual at the foot of the retort, and carrying a stream

of naphtha is decomposed, and passing up through the lime "is converted or fixed into a permanent illuminating gas, by its contact with the hot lime in the upper part of the chamber." Other claims, also made, credit the lime with a peculiar but not satisfactorily explained action upon the gas, which results in "decreased purification," etc. To the untutored mind it would appear that the limestone simply acts as would fire brick, or "other refractory substances," to "fix" the gas. Plants of this form have been erected at Albany, Utica, Brooklyn and New York City, N. Y.; Boston, Mass., and several minor points.

These comprise all the retort methods of which I have any knowledge, for the manufacture of water gas. I am aware that sundry of what are known as "oil bench"—"processes," in which the oil is injected into retorts by a steam jet—claim to so manufacture a water gas. In the accepted sense of the term, however, this does not constitute a water gas process. I think that I have covered the recognized retort methods as above.

We now come to Class 2 or "Generator Processes." This class can be readily sub-divided into two divisions, viz.:

Section A.—Generator processes in which a non-luminous water gas is first made, which is afterwards carbureted; usually in a second apparatus, by the second fire, and in a second operation; and

Section B.—Generator processes, in which an illuminating water gas is made, carbureted and fixed entirely in one operation—one apparatus and with one fire; usually through the medium of a "superheater."

We have in Section A:

1st. The Tessie du Motay apparatus.
2nd. The Wilkinson apparatus.
3rd. The Jerzmanowski apparatus.
4th. The Hanlon & Johnson apparatus.
5th. The Edgerton apparatus.
6th. The Harkness apparatus.
7th. The Mackenzie apparatus.
8th. The Egner apparatus.
9th. The Meeze apparatus.

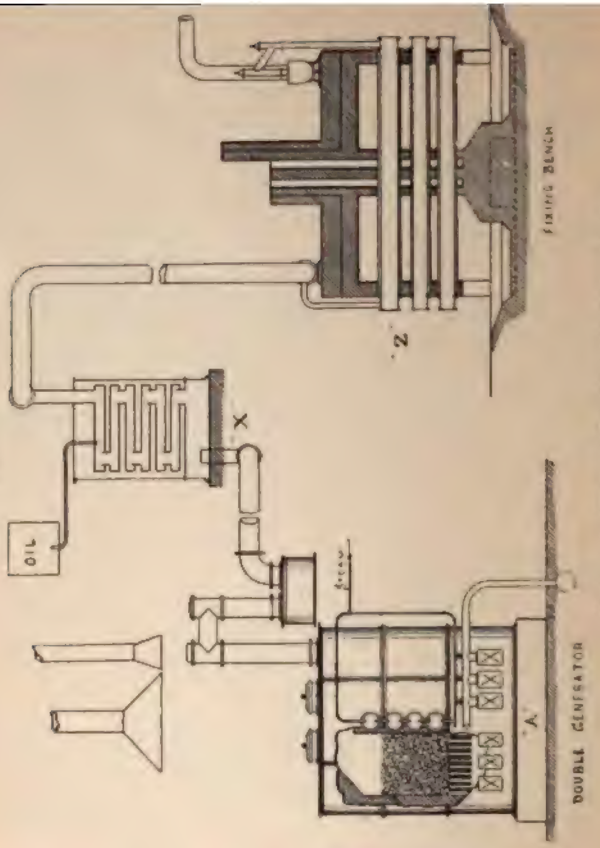

Fig. 11.—Tessie Du Motay Apparatus.

The Tessie du Motay Apparatus:—Pre-eminently the most typical of its class is the Tessie du Motay form, which I illustrate in Fig. 11. "A" is the "gasogene," or simple generator, consisting of the usual fire-brick lined shell with coal bed, grate, air blast, and steam inlets, etc. In this, after attaining the proper heat, by "blowing up," the blast is stopped, and steam, admitted beneath grate, in passing up through the bed of incandescent coal, is decomposed, and the hydrogen gas thus formed passes to the "hydrogen holder." It then is brought to the carbureter "X," which consists of a series of shallow trays

or pans of naphtha, heated to a vapor by steam in close contact.

The gas, enriched by, and carrying these naphtha vapors in suspension, passes to the retort "Z," in passing through which it is "roasted" or made into a fixed, permanent gas. It then goes to the purifiers, etc. You will note that in this apparatus, in blowing up the heat, the generator gases pass out the stack and up the chimney, and are absolutely lost.

The method above described, although named after the French chemist, Tessie du Motay, differs considerably from the original plan of working, as contemplated by him. This first plan covered the distribution of an "oxygen" gas, a plant for which was erected in New York, early in the seventies. This proved unsuccessful. Later, the system was again taken up, very materially modified, and brought to its present form, and in 1876 the first plant of any magnitude was erected for the Municipal Co., of New York, by the Continental Iron Works, of Brooklyn, N. Y., to whose energy much of the success of the system has been due. Other plants have since been erected at the New York, the Knickerbocker and the Harlem stations, New York City, and also at the Fulton Municipal Works, Brooklyn; Yonkers, N. Y.; Jacksonville, Fla., etc.

The Wilkinson Apparatus:—Closely resembling the preceding, but of somewhat later appearance and construction, is the Wilkinson apparatus—shown in Fig. 12—as constructed by Messrs. Bartlett, Haywood & Co., of Baltimore. From an authoritative description, I quote: "Steam is decomposed in the generators, and, after a scrubbing process, is carried to the hydrogen holder. From thence it passes through a station meter to the 'illuminator,' where it meets vapors of naphtha—produced by steam to a temperature of 240 to 260 deg. The mechanical mixture of water gas and naphtha vapors is carried to the benches in which the mixture is converted into a fixed gas. The benches are through benches of double the length of ordinary retorts; the mixture enters at one end and the gas issues at the other." From this you will see that the system is very similar to the preceding, and the claims of the one are practically the claims of the other, and are (aside from the general claims of economy, etc., common to every apparatus):

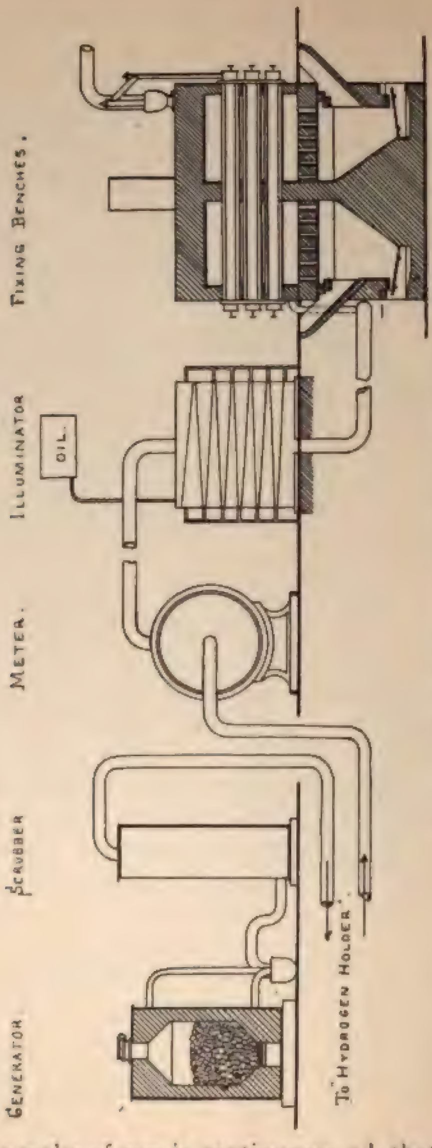

FIG. 12.—THE WILKINSON SYSTEM OF MANUFACTURE.

1st, that the make of gas is continuous; 2d, that an absolutely uniform gas is produced, and 3d, that gas is produced at an absolutely uniform speed.

The first Wilkinson plant was erected, and is in operation upon a large scale, at the New York Mutual Co.'s works. Later plants are at Baltimore, Md.; Washington, D. C.; Buffalo and Rye, N. Y., etc.

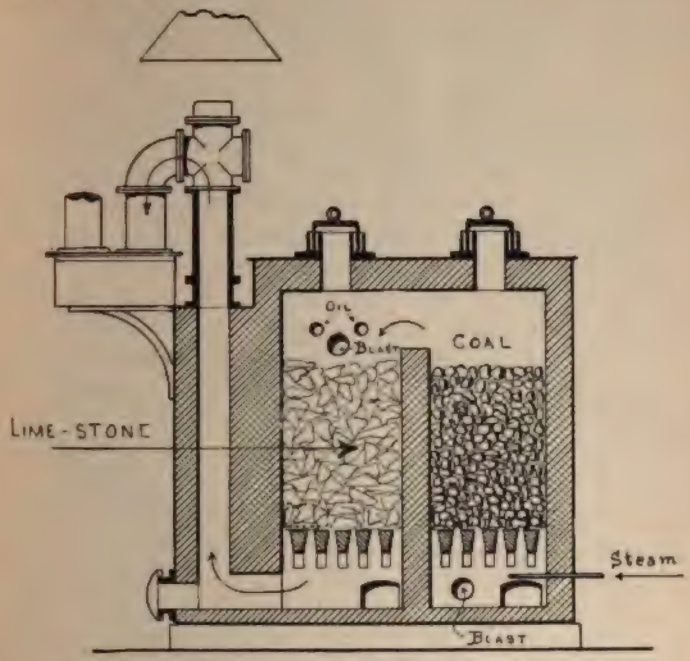

FIG. 13.—GENERATOR OF THE JERZMANOWSKI APPARATUS.

The Jerzmanowski Apparatus:—This apparatus, as erected at the "Equitable" works, New York, Chicago, Baltimore, etc., so strongly resembles the preceding, for the generation of the hydrogen gas, the latter carburetion, and the final fixing of the same, by passing through retorts, that a detailed description would be largely a repetition of what has gone before. The chief point of difference is in the generator. This, in addition to the chamber of incandescent coal, has a secondary chamber (see Fig. 13), containing "hard burned lime," or limestone, which is heated by the products of combustion from the first chamber or generator proper. In making gas, steam, in passing through the coal, decomposes and meets, at the top of

coal bed, hydro-carbon vapors; together they pass dow through the limestone (which practically forms a super-heatin or *fixing* chamber), forming, perhaps, a 15 candle gas, which afterwards enriched, as desired, to any degree and furthe fixed by carbureters and retorts, as previously described.

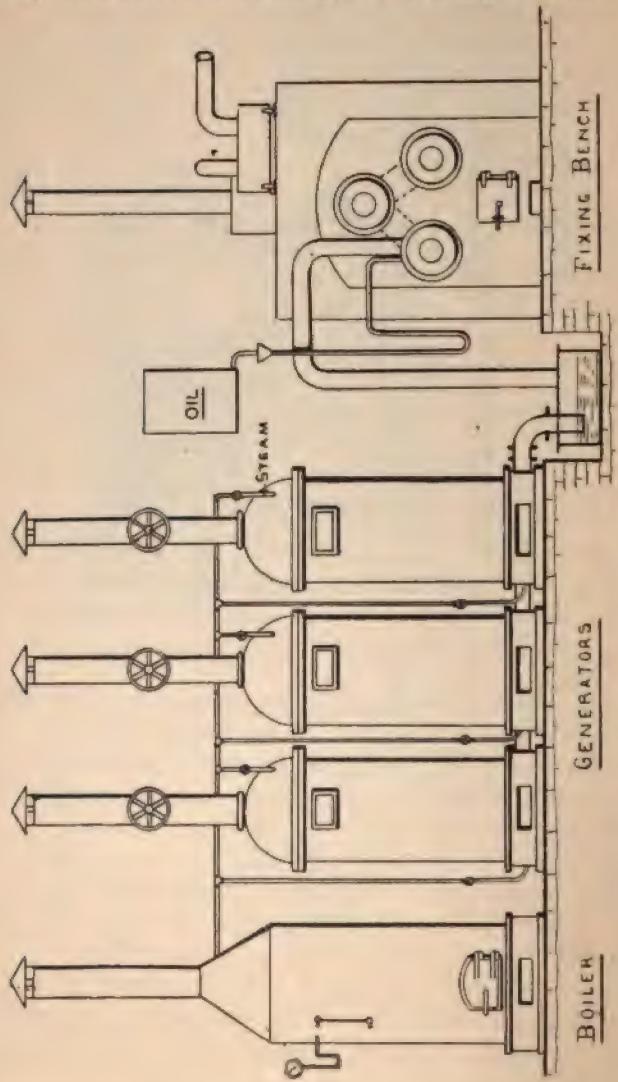

FIG. 14.—HARKNESS APPARATUS.

The Harkness Apparatus:—It is of interest to note in this connection, as indicating the difference between success and failure, a plant erected at New London, Conn., of the Harkness form, patented 1874, which, working upon almost the same lines as the preceding, yet, from the crudity of certain essential details and poor structural design, has amounted to nothing.

The method of manufacture, as in the preceding, consisted of the production of a non-luminous water gas in a generator (see Fig. 14), from which the gas was led off to retorts, carbureted with naphtha vapors, and "roasted" or made into a permanent fixed gas. The generator was small, difficult to fire, and to maintain proper combustion in; the coal was gotten to a proper heat by a slow draft, as compared with the modern blower or forced draft. This made an extremely slow production of gas, which in turn produced high labor account. To correct this, several generators were operated in conjunction. The gas went as made, regularly or irregularly, to the retorts—no hydrogen holder intervening. While this system had strong claims made for it at the time, as a matter of fact, it was short-lived. But one plant, as far as I know, was erected, and that has now been in disuse for some years.

The Hanlon and Johnson Apparatus:—In 1878, under the auspices of the "United Petroleum and Water Gas Co." appeared the system of manufacture known as the "Hanlon and Johnson," which attained some little success at the time, and which I illustrate in Fig. 15.

In this "A" is the usual plain generator for the production of non-luminous water gas, which is led off to one holder. "B" is a "Hanlon Bench," for the production of a pure oil gas, which is led off to another holder. An exhauster "X" draws gas from each holder, mixing in the pipes, and it is obvious that by the adjustment of valves the proportion of water gas and oil gas drawn from their respective holders and, therefore, the exact candle power desired can be maintained to a nicety. In theory this was excellent; in practice it was unsatisfactory and expensive. The gases having but a mechanical mixing, developed a strong tendency toward condensation, and had the lack of "stiffness" of flame peculiar to oil gases. The abso-

lute lack of utilization also of the generator gases was a wasteful feature.

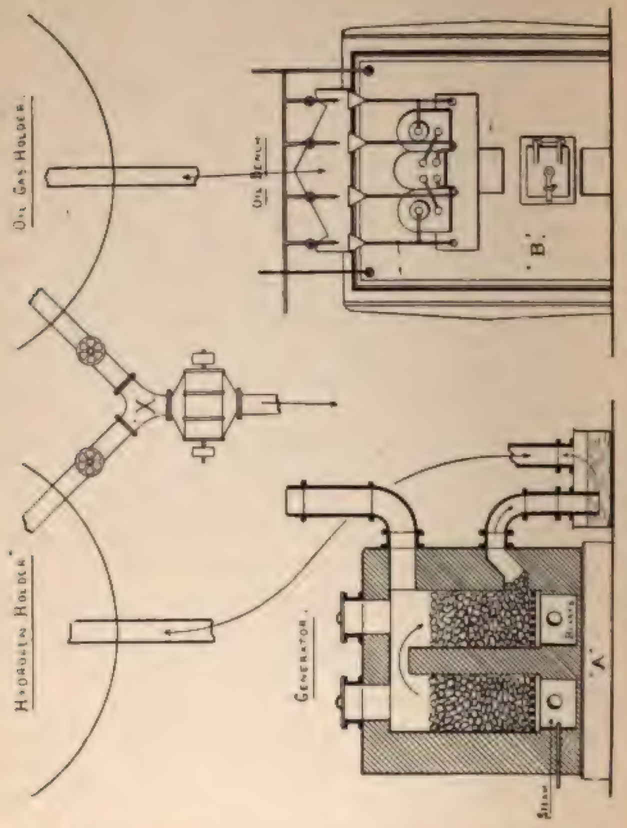

FIG. 15.—HANLON AND JOHNSON APPARATUS.

There is no better illustration of the advancement of the art of water gas manufacture from uneconomical to economical methods, than to state that in the cities where the "Hanlon and Johnson" apparatus was some ten years installed, viz.: Rochester, N. Y.; Reading, Penn.; Dover, N. H.; San Francisco, Cal.; Atlantic City, N. J.; and several other points, almost without exception, these plants have since been superseded by more modern and more efficient water gas systems.

The Edgerton Apparatus:—A system very similar to the above,

but, in at least one feature, a decided step in advance, is the Edgerton, which I show in Fig. 16.

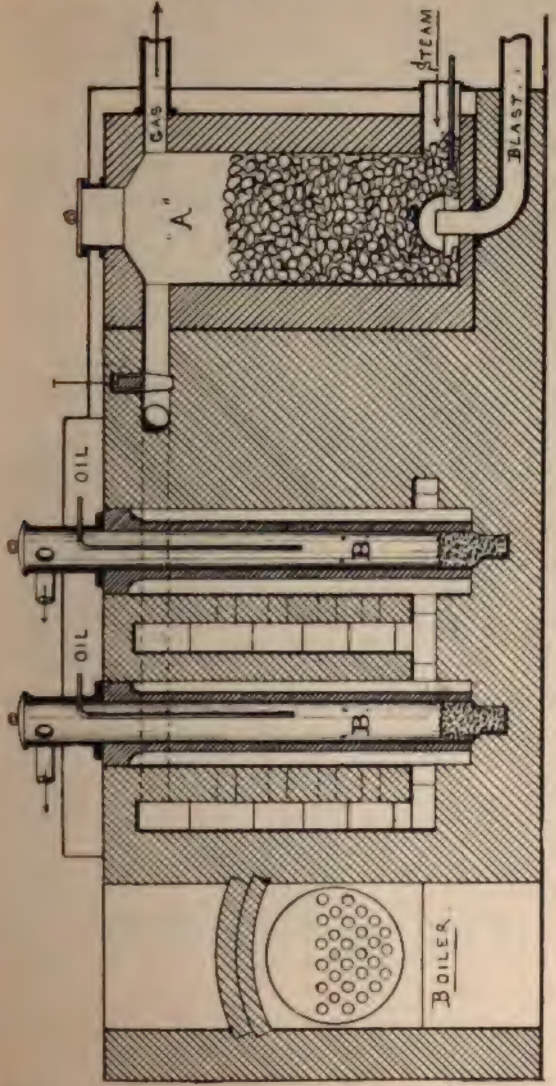

FIG. 16.—THE EDGERTON APPARATUS.

In this "A A" are generators as before, for water gas; "B B" are vertical retorts for the production of oil gas. The improve-

ment comes in from the fact that the generator gases, which in all the systems heretofore mentioned in the present class, are allowed to go to waste, are, in this apparatus, to a certain extent utilized, being used to fire the retorts which make the oil gas; a continuous supply of gas for this purpose being had by using two generators in conjunction. While one is making water gas the other is being "blown up," and vice versa. The water gas and oil gas after being separately made, are drawn by exhausters through meters and mixed in measured quantities

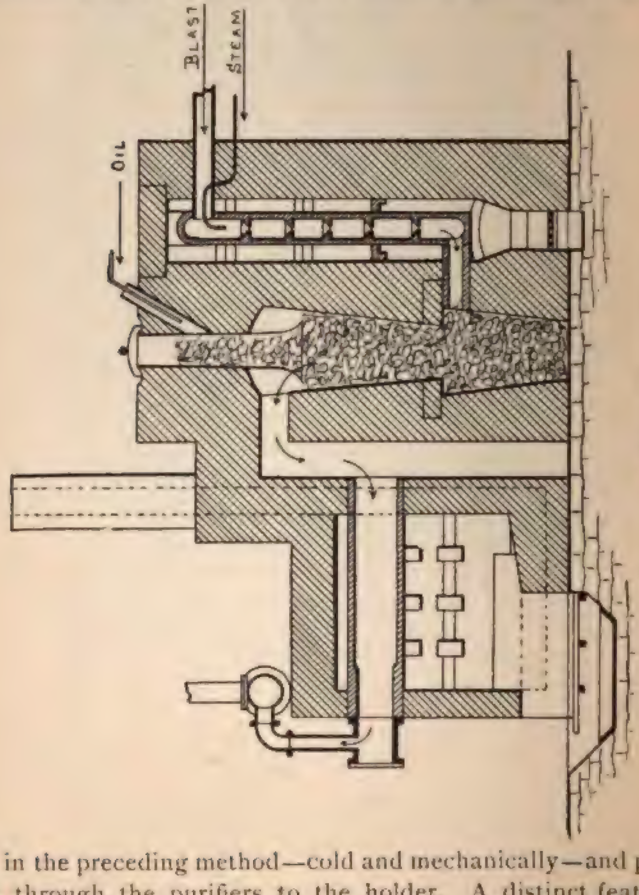

FIG. 17.—MACKENZIE APPARATUS.

as in the preceding method—cold and mechanically—and passe on through the purifiers to the holder. A distinct feature c the Edgerton system was the distribution of a gas of very hig

ndle power, selling it upon the basis of the amount of *light* ceived, with the use of a "dollar and cents" meter. Plants on this system have been erected at Danbury and Walling-d, Conn.; Pensacola, Fla.; New Orleans, La., etc.

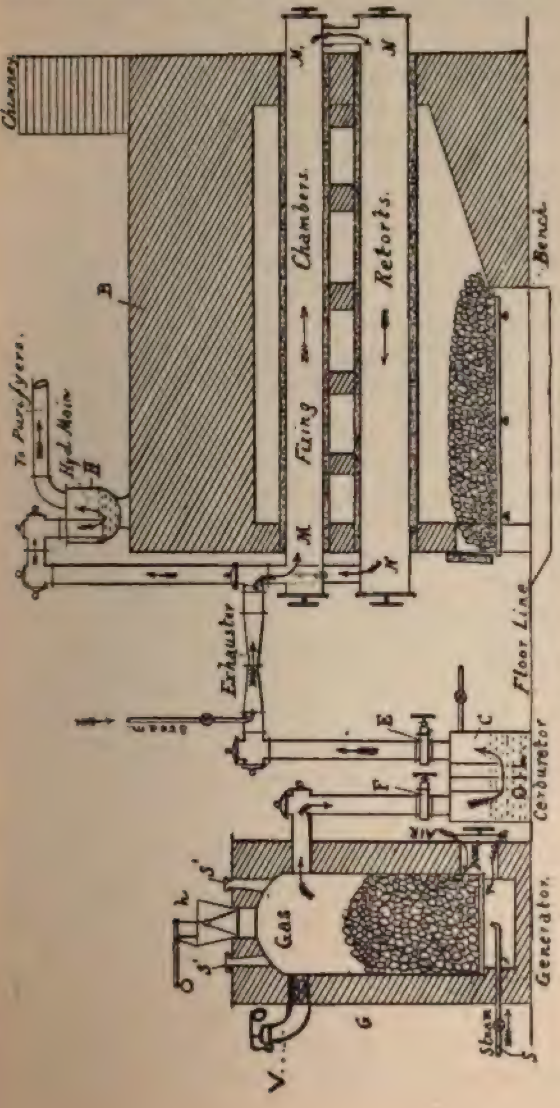

FIG. 18.—THE EGNER APPARATUS.

The Mackenzie Apparatus:—Still another form of apparatus, using a generator separately, and afterwards carbureting the gas, is the Mackenzie, which is of interest as showing an attempt to get a continuous production of gas with the use of a generator, but with the usual result, viz.: the gas is loaded with nitrogen, which is its own condemnation.

In the Mackenzie method, which I show in Fig. 17, the generator fire is blown up continuously. At the same time a steam jet is also continuously admitted, and the resultant "producer" gas is led off to a bench of ordinary retorts, and carbureted by passing through same, with naphtha added. Sufficient coal gas is made in one or two retorts to produce coke for firing the bench, which coal gas is mixed with the water gas at the hydraulic main. While a number of these plants were erected some years ago, they have all, as far as I know, fallen into disuse—the nitrogen in the gas probably being a chief factor. The last one, to my knowledge, now in operation, is just being supplanted by a later water gas process.

The Egner Apparatus:—The apparatus of Frederic Egner, of 1887, shown in Fig. 18, is very similar in operation to the preceding, and illustrates another effort to attain a continuous manufacture, with the use of a generator. "A" is the generator for making "producer" gas, "B" is a "carbureter" seal, through which the gas, in plunging, is enriched by the oil or naphtha, which replaces the usual water for sealing. From it the gas is conducted to the "fixing" chamber, or retort, in passing through which the gas is made permanent, and thence passes to the hydraulic main, purifiers, etc. A plant of this form has been erected at the Laclede works, St. Louis, and one, also, I believe, at Waco, Texas.

The Meeze Apparatus:—The last form of apparatus of the class which we are now considering is that of A. G. Meeze, of England, patented 1886, and controlled by the "International Gas Co.," plants of which have been installed at New York, N. Y.; New Orleans, La., etc.

This apparatus (see Fig. 19,) consists essentially of fire clay retorts in an ordinary setting. In the center of each retort is a 4 "ingression pipe" (leading almost to the rear end) which is

filled with "bafflers," through which a jet of superheated steam and hydro-carbon vapors is injected These vapors, after going through the "bafflers" and expanding from the "ingression pipe" into the body of the retort, pass through a second series of "baffle plates" to the front, to standpipe "A" and hydraulic main. The rich oil gas thus formed is afterwards reduced by a mixture of water gas, made by any generator method, which water gas may be admitted in the retort, hydraulic main or other point.

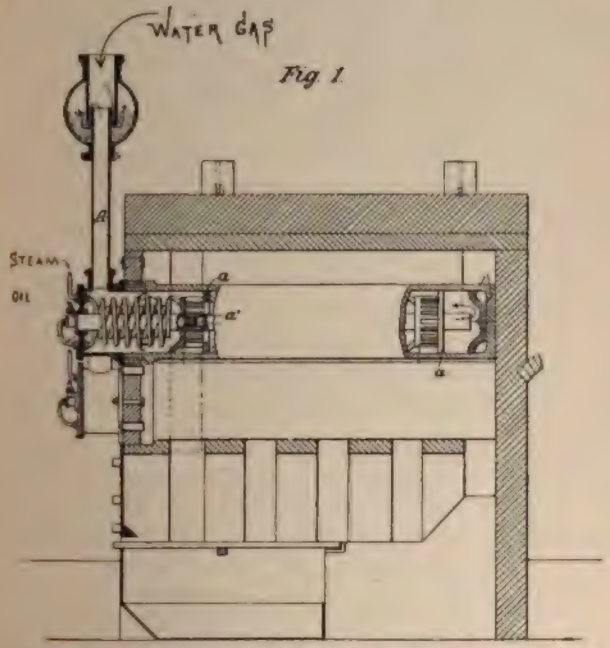

FIG. 19.—THE MEEZE OIL AND WATER GAS APPARATUS.

I think you must have already noticed the main feature—I might say the main fault—of this class of apparatus just described, viz.: that in all these methods of manufacture to make a fixed illuminating gas, two operations are involved—first the *making* of a water gas and afterwards the *carbureting and fixing it.*

We now come to the consideration of a type of direct apparatus in which these two operations are combined in one. And

in this class, in noting the various forms that have achieved commercial success, we find that no matter how much they differ in design, in proportion, in detail, or in construction, there is one great central feature common to all—a feature that has made the system a success, and which is the basis of their classification, as a process—and that feature is: the use of a superheater for storing up waste heat from the generator, by which to fix or make permanent the mixture of steam and oil gases.

In the second class—or Section B ("Generator Processes in which water gas is made, carbureted and fixed entirely in one operation, one apparatus, and one fire; usually through the medium of a superheater")—we have:

1st. The Lowe apparatus.
2d. The Granger apparatus.
3d. The Hanlon-Leadley apparatus.
4th. The Springer apparatus.
5th. The McKay-Critchlow apparatus.
6th. The Flannery apparatus.
7th. The Martin apparatus.
8th. The Pratt and Ryan apparatus.
9th. The Van Steenburg apparatus.
10th. The Loomis apparatus (early type for illuminating gas.)

The Lowe Process and Apparatus:—The credit for the invention of the process (which is the basis of the class of apparatus we are now about to notice), whether considered chronologically, practically, or legally, belongs unquestionably to Prof. T. S. C. Lowe, of Norristown, Penn.

Identified with gas interests since the war of the rebellion, where as chief aeronaut of the army of the Potomac, he was engaged in the manufacture of gas for ballooning purposes, and later connected with the illuminating gas interests, in 1872 he took out a patent containing some of the features of and leading up to the patent of 1875, which is the base of the modern water gas system. This, as to time, is about the same period as the first Tessie du Motay plant in New York.

Devoid of technicalities, the Lowe process covers broadly the use, in connection with a generator, of a superheater or fixing chamber, fired by the combustion within it of the gases

which are formed in "blowing up the heat" in the generator; also the introduction of oil, or other enriching substances, into the hydrogen gas and the fixing of the two by passage through the superheater into one permanent fixed gas. The process also covers the use of the superheater for superheating steam, if so desired, instead of for fixing the gas.

The first Lowe apparatus was erected in Phoenixville, in 1873; the next at Conshohocken, and the third at Columbia, Penn., all by the inventor himself.

Messrs. S. A. Stevens & Co. then took an agency (their first works being at Utica, N. Y.,) and later organized the "American Gas, Fuel and Light Co." to whom a general license was given. About the same time Messrs. A. O. Granger & Co. commenced building this apparatus, closely followed by Messrs. Pierson Bros., and the "National Gas Co."

By these various parties, Lowe apparatus was erected at very many places throughout the country, until 1882, when the patent rights were acquired by the United Gas Improvement Co., of Philadelphia, who have since continued the erection of the apparatus.

I show two cuts of the Lowe apparatus. Fig. 20 shows the earliest and original form. Fig. 21 shows the latest construction. In general features, sequence of parts and operation, they are alike: "A," the generator, a fire-bricked lined chamber, contains anthracite coal, or coke, which is raised to a state of incandescence by an air blast, admitted beneath the grate. The products of combustion, or gases, formed in this operation pass out at the top through the "goose-neck" connection "C," to the base of the superheater "B," where, by the admission of a secondary air blast, they are burned, heating the fire brick with which the superheater is filled. When the proper heats are obtained, the blasts are shut off, stack valve closed, and steam admitted beneath the grate in generator "A." This passing up through the coal, and decomposing, forms a non-luminous water gas, and meets the oil vapors for enriching, which are admitted through pipes in the top of the generator. The oil and steam gases then pass through pipe "C" to superheater, where, by contact with the red hot fire brick, they are "fixed" into a permanent illuminating gas.

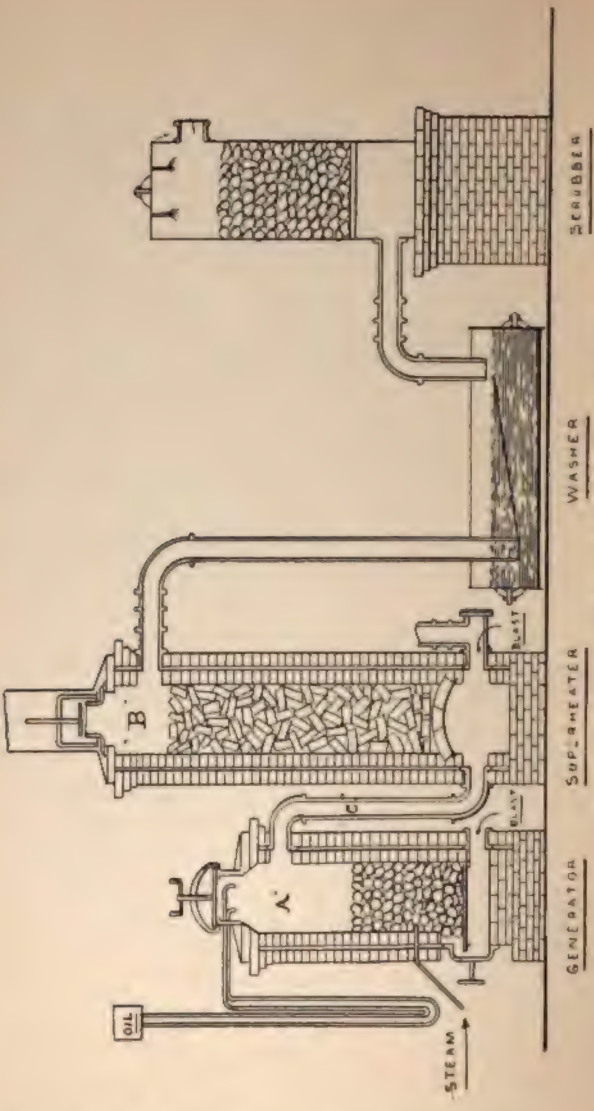

FIG. 20.—ORIGINAL FORM LOWE APPARATUS, 1873.

Fig. 20 is of interest as showing the crude early construction of the apparatus, and the old form of hydraulic seal or "washer," with diaphragm, which, holding the gases under water, not only

"washed" the gases, but frequently, also, washed out some portion of the illuminants. For which reason this form was speedily discarded.

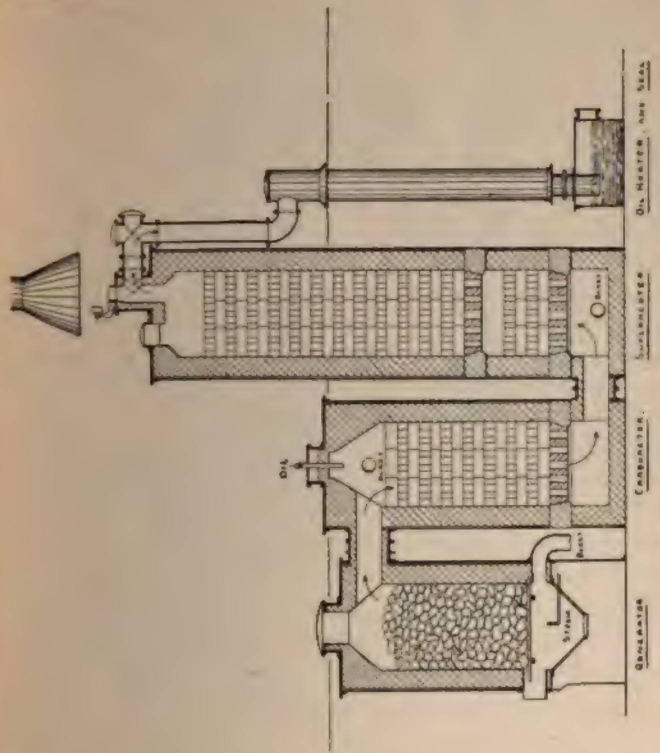

FIG. 21.—MODERN FORM LOWE APPARATUS, 1889.

Fig. 21 shows the modern or "double superheater" construction—the chief changes (aside from the mechanical and detail work) being the increase in depth of the generator, and the enlargement of the old pipe connection "C" into an entire superheater.

The filling brick in this first superheater, or "carbureter," as it is usually termed, from the fact of the hydrocarbons being often there admitted, is peculiarly arranged for the use of heavy oils. Ordinary checker bricks are used, but so laid up that continuous "core holes" are formed from top to bottom, which in the use of crude oils, allow the heavier impurities to drop entirely to the cleaning doors at base.

A highly efficient form of the double superheater type is that known as the "Humphrey's" setting, as erected at Chicago, Toledo, Terre Haute, etc. In this arrangement two complete sets of apparatus are connected by flue at the generators. Both sets of apparatus are "blown up" together. In gas making steam is admitted at the rear of one set, is superheated and carbureted in this set, and passing on to the second is finally gasified and "fixed." During the next run this course is reversed, steam being admitted in the opposite set. This setting is particularly adapted to large works.

The claims for this form of apparatus, aside from the general ones of high economy, etc., are, first—by the great depth of generator, the ability to use coal or hard or soft (gas house) coke at pleasure; second, by the utilization of waste heat, for the highest pre-heating of the oil, and by the use of two superheaters, maintained at different heats, the ability to use, to the best advantage, cheap crude oils, or distillates, etc., and, third, by the great superheating capacity, the ability to properly fix the gas at moderate heats: so doing away with the danger of lamp-black and naphthaline accompanying high heats, and the question of lack of fixing of the gas, present in some other forms of apparatus.

The Lowe apparatus, in various forms, has been erected all over the country. I will not here attempt to list the places; a glance at the chart behind me will show its record.

The Granger Apparatus:—The first of this class to make its appearance after the Lowe was the Granger apparatus, of which I show a typical setting in Fig. 22.

The firm of A. O. Granger & Co., dating from 1878, originally erected Lowe water gas apparatus, under license from S. A. Stevens & Co., then controlling the patents. In doing this, many improvements in detail and in construction were made, and finally, patents were taken out for the "Granger" form, which you can readily see is an evolution from the Lowe. The two most essential differences were: First, the doing away with the old goose neck, heat-radiating connection ("C" in Fig. 20) by locating the generator in the cellar, with the shells slightly lapping, thus giving a short direct connection from shell to shell, and bringing all the operations of gas making upon one

floor; and, second, the introduction of the oil, at a high temperature, in the form of a spray or vapor, at the base of the superheater; the claim being that in such a form it was much more readily taken up and gasified by the hot stream of water gas than as before when dropped upon the top of the coal bed of

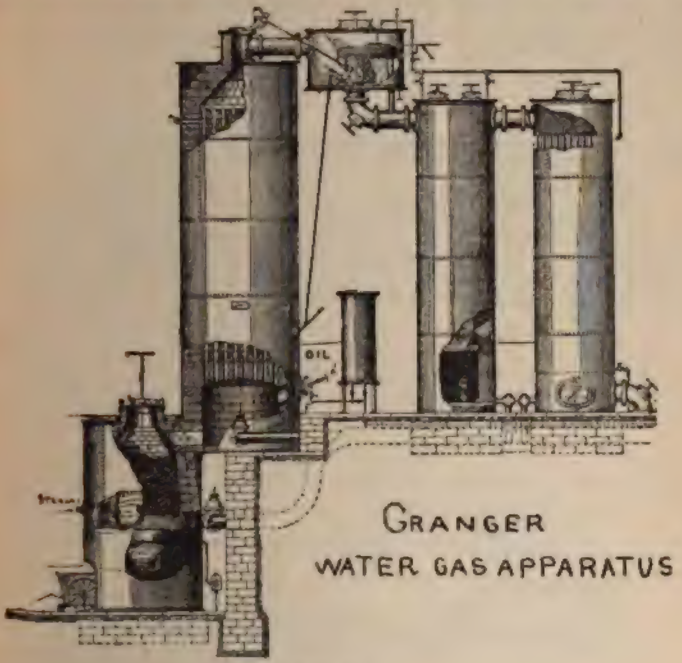

FIG. 22.

the generator in a solid stream. Messrs. Granger & Co. went largely into the detail of parts and of construction, and by erecting a simple and effective plant, did much to popularize this type of water gas apparatus. Their efforts were highly successful, for up to 1885 they erected, chiefly in the middle and eastern States, over seventy sets of apparatus. One plant erected by this company at Chicago, with generator 13 feet in diameter, is interesting as indicating the limit of size to which a generator may be made. This plant in question, while turning out great quantities of gas, yet owing to the large mass of fire to be handled, and practical difficulties of construction and

operation, was not entirely satisfactory, and precisely as experience has determined a practical limit in size for retorts, so were Messrs. Granger & Co. well convinced that the limit for size of generators had been exceeded.

In 1885, the Granger Water Gas Co., was consolidated with the United Gas Improvement Co., since which time this form of apparatus has been erected by the latter company.

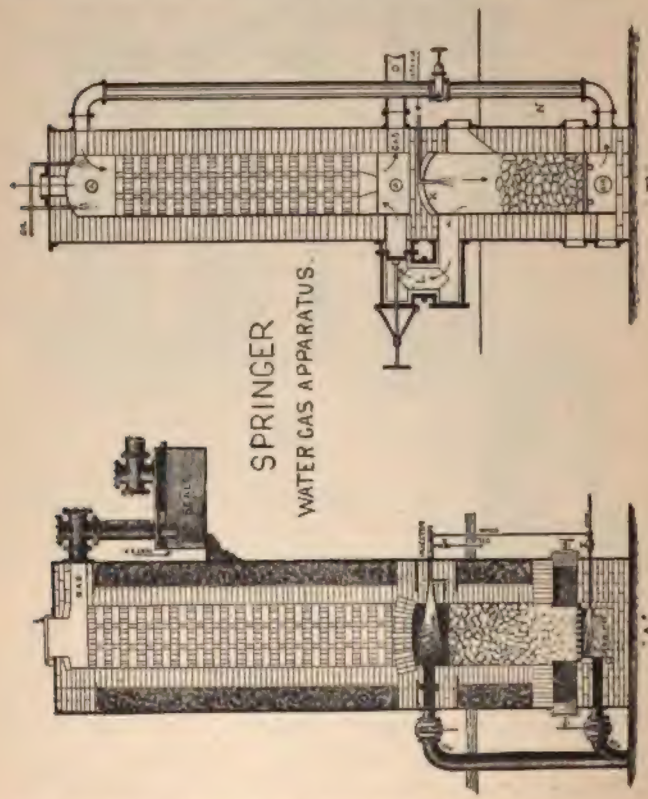

FIG. 23.

The Springer Apparatus:—Closely following the preceding, as a practical and efficient apparatus, comes the "Springer" cupola system. This form of construction, under the patents of Mr. T. G. Springer, which were later transferred to the "National Gas Light and Fuel Co.," by whom the system is now controlled, has the chief distinctive features of a generator and superheater

entirely in one shell; of certain new methods of introducing the oil and of certain modifications of the course of the gas through the apparatus; the advantages claimed being the minimum of radiation and the maximum of heat conserved for the superheater, together with superior economies in general.

This single shell, or "cupola" form of apparatus, was also one of the several earlier forms of apparatus erected by Prof. Lowe, and has since been adopted by later constructors, as will be noted further on.

The first Springer plant was erected in Chicago, in 1882, since which time it has rapidly grown in favor, large plants having been erected in San Francisco, St. Paul, Minneapolis, Chicago, etc., and also in many smaller cities and towns, chiefly in the Western States, around the upper Mississippi.

Fig. 23 illustrates this apparatus; "A" being the original form and "B" a modification of it. In this latter form, the generator is "blown up" in the usual way, the gases passing through the combustion pipe "L" around the solid arch "K" to the superheater.

In making gas, steam admitted at "M" (the pipe "L" being closed) passes down through the coal bed and up the external pipe "N," to top of superheater, where it meets the oils, which together pass down through the superheater, and out at "O." A still later modification of this construction permits the course of the steam and gas currents to be either up or down.

The Hanlon-Leadley Apparatus:—The first Hanlon-Leadley apparatus was erected at Passaic, N. J., 1884, by the United Coal and Oil Gas Co. controlling the patents. Since then numerous plants have been erected at other points, viz.: Reading, New Haven, Chicago, Manchester, Philadelphia, etc. The apparatus, containing all the essential features of the Lowe, is chiefly distinguished by the use of two or three generators on a common communicating base. Perhaps the best illustration of which is the latest plant erected, known as the "W" setting, and which I show in Fig. 24. The three generators are all blown up to a proper heat together, part of the products of combustion being used to heat the small superheaters "B," the bulk of the gases, however, passing through the three pipes, "K" "K" "K," to heat the two superheaters "P" "P," also

on a common base. When ready to make gas, the valves "O" "O" are closed. Steam is first admitted at the top of both small superheaters "B" "B," and passing down is superheated, and thence continuing down through the outside generators, the two streams meet at base of the center generator. They pass up through this generator and to this point their course has described the letter "W," whence the name of this setting. Oil is admitted at top of center generator, and the gases pass over through center pipe "K," to superheater, for fixing as usual. The usual claim for high economy is made, in this case being based largely upon the superheating of the steam, and of the operation of several generators together. From this latter it is obvious the apparatus is best adapted to works of a large size.

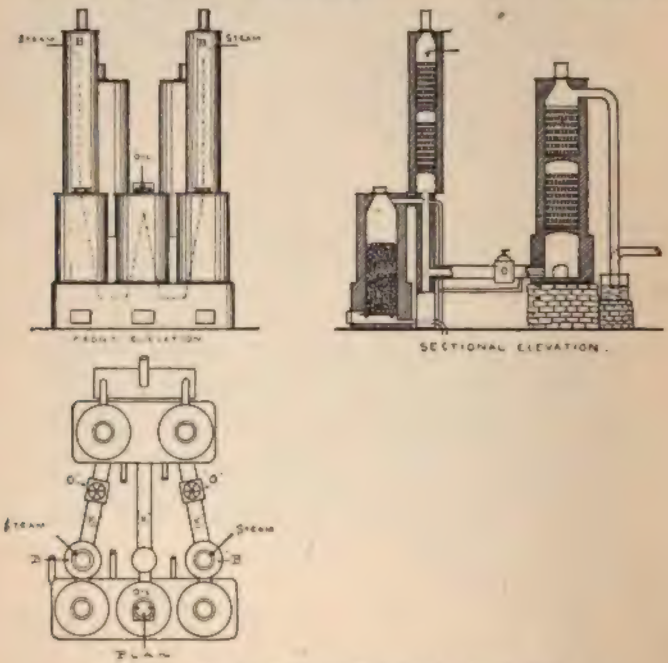

FIG. 24.—THE HANLON-LEADLEY APPARATUS.

The Flannery Apparatus:—Another type of apparatus, and one that has been introduced at some of the principal gas works of the country, is that built under the patents and de-

signs of Mr. Jos. Flannery, and which I illustrate in Fig. 25. In general appearance it differs from the usual series of cylindrical shells, in being built in a rectangular wrought shell, and in pairs; although the halves of these pairs are operated independently of one another. Internally, the chief difference is, as usual, in the handling of the oil. The generator "A" is

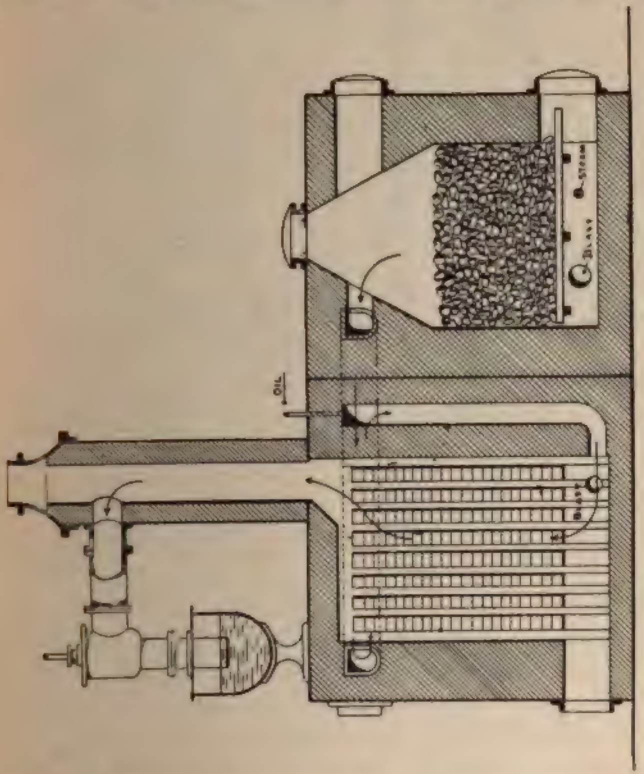

FIG. 25.—THE FLANNERY APPARATUS.

fired, and hydrogen gas made in the usual manner. Upon leaving the generator the gas passes into a "D" shaped retort, located around three sides of the top of the superheater. In this retort the oil is admitted and vaporized, the water and oil gases traveling through it together around the shell, back to the starting point, where they descend the vertical flues "M" to base of superheater, to be fixed in the usual manner. This apparatus, first erected at Middletown, Penn., in 1881, has

since been introduced upon a large scale in Boston, Chicago, Jersey City, New York, etc. Other plants have been erected in St. Jago, Cuba; Duluth, Minn; Wilmington, Del., etc.

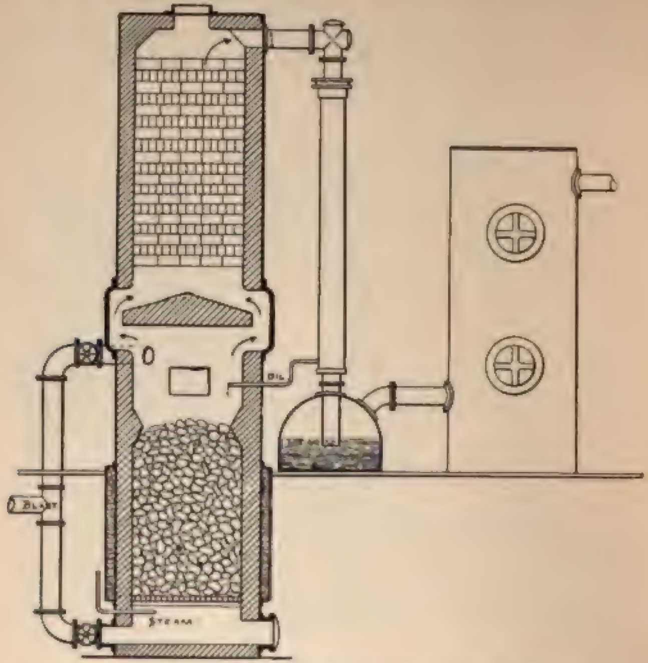

FIG. 26.—THE MCKAY-CRITCHLOW APPARATUS.

The McKay-Critchlow Apparatus :—In Fig. 26 I show a cut of what is commonly known as the McKay-Critchlow apparatus, although, strictly speaking, built under the patents of Peter English, of 1884. These patents were for a water gas generator in a single shell, having the sole distinctive feature, as shown by the cut, of a solid arch, separating the generator from the superheater, *around* which the gases pass, instead of the usual *perforated* arch *through* which the gases may pass. By reason of this, "greatly improved results" were claimed; upon just what basis is beyond my comprehension.

The first plant of this form was erected in London, Ont., in 1882. About 1884 Messrs. McKay & Critchlow, holding patents for the carbureting of natural gas, by means of a cupola,

formed with W. H. Denniston, the "American Gas Improvement Co." of Pittsburgh, which company acquired the rights to the Peter English apparatus, and also the patents of Messrs. Robt. Young and J. H. McElroy, for the treatment of natural gas.

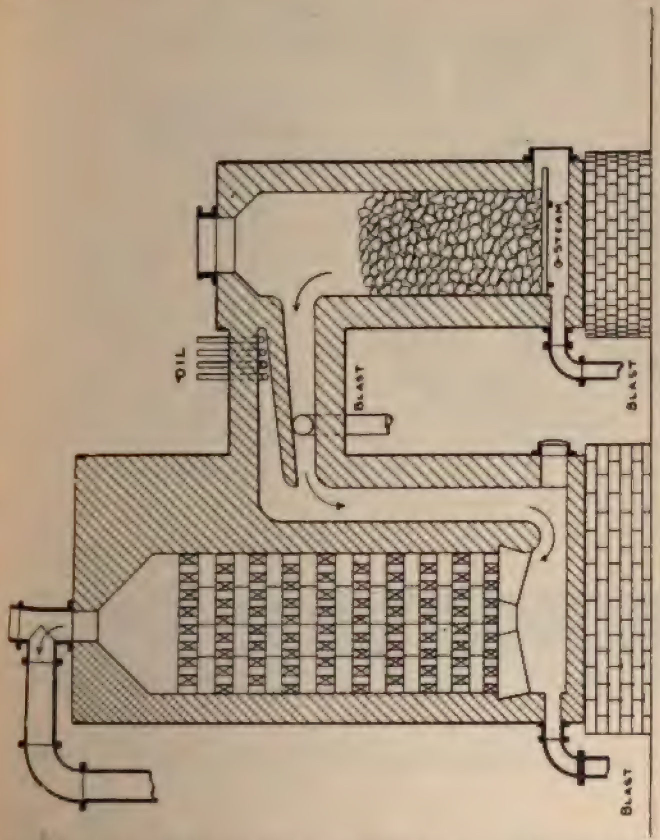

FIG. 27.—MARTIN APPARATUS.

Although natural gas can undoubtedly be carbureted in very many different ways, yet I think I am right in saying that the most successful efforts, commercially speaking, have been under the above patents, with the use of a cupola, in which the gas simply replaces in part, the steam of an ordinary water gas process—passing through a generator and being decomposed by the coal, and afterwards being carbureted and fixed in a

superheater. From this first use for natural gas the Peter English very readily drifted into use for a straight water gas apparatus, and we find many plants erected for either purpose among the small gas towns of New York, Pennsylvania and Ohio.

In 1888 the several patents above were acquired by the United Gas Improvement Co., by whom they are now controlled.

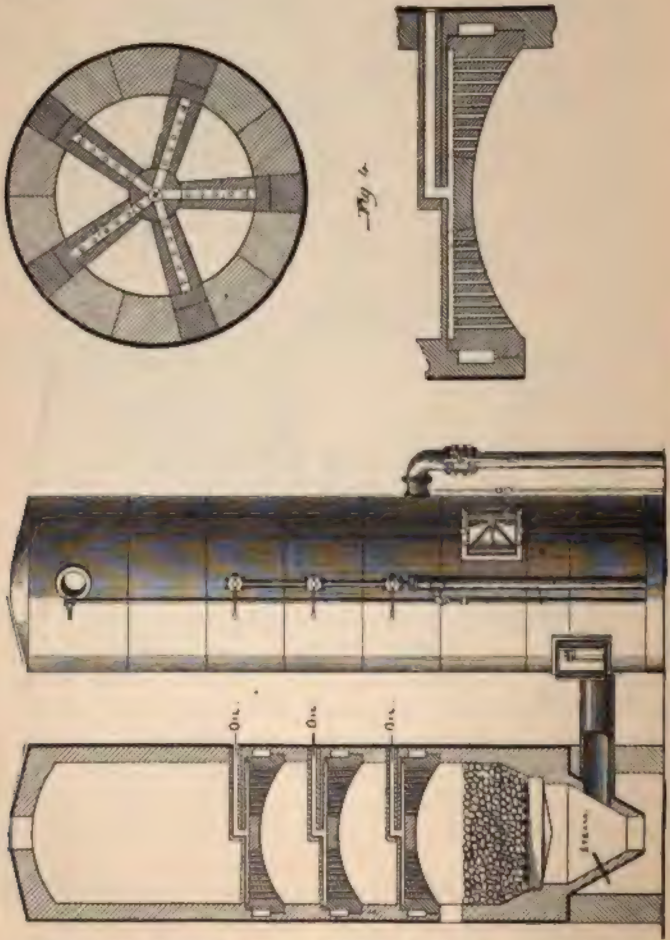

Fig. 28.—Pratt & Ryan Generator.

The Martin Apparatus:—In Fig. 27 I show you still another

form of apparatus, known as the Martin. This is similar to other types in operation and sequence of parts, but differs, as usual, in the introduction of the oil.

In this apparatus the connecting flue from generator to superheater is broadly expanded, and has at its upper part "A," a tile or slab upon which the enriching naphtha is dropped from inlet pipes above. This oil is vaporized by the hot water gas and carried on to the superheater, where the two are "fixed" as usual.

Plants of this description have been erected at St. Paul, Minn.; Newburgh, N. Y.; Washington, D. C.; Macon, Ga., etc.

The Pratt & Ryan Apparatus:—Still another form of the cupola, or single shell type, and the last that has appeared upon the commercial field, is the Pratt & Ryan apparatus, dating from 1887, which I show in Fig. 28. You will see at once that in general arrangement it is the same as some of the preceding forms, but differs somewhat in the filling of the superheater. In place of the usual checker brick is a series of fire brick arches; each of which also serves as an oil inlet, the arches being cored and perforated. The oil is admitted in the centre of each arch, radiates through each arm, and emerges into the chambers between each, where it is taken up by the flow of water gas; any particular arch is used at pleasure, according to the heat of the superheater. Several large cupola generators in Chicago have recently been remodeled to this construction, and smaller plants have been erected at Goshen, Ind.; Creston, Iowa, etc.

The Van Steenburg Apparatus:—The apparatus under the patents of B. Van Steenburg, 1881, which I illustrate in Fig. 29, may be taken as a fair example of numerous attempts (such as the Averill, Boeklen, etc.,) to make a compact generator-superheater all *in one chamber*. In this case it is accomplished by inserting fire-brick tile "D" in the top of the generator, to give superheating or "fixing" capacity. These tiles, while heated by the gases from the generator, do not begin to utilize all the heat therein—simply absorbing the sensible heat—no secondary air supply being given for combustion. From this very minimum superheating capacity, it is obvious that the ap-

paratus is limited to a moderate make, and to the use of the lightest hydro-carbons (naphtha, etc.) to produce a gas at all fixed.

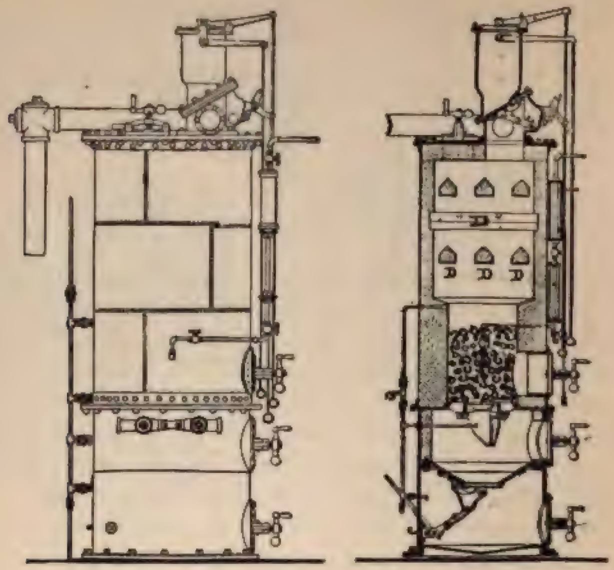

FIG. 29.—VAN STEENBURG GENERATOR.

Several plants of this form were erected some years back, at Goshen, Herkimer, Amsterdam, etc., N. Y.

The Loomis Apparatus:—While the Loomis system has been mostly pushed upon the lines of a non-luminous fuel gas, there is one plant of this name erected at Cottage City, Mass., in 1884, that comes within the scope of the class we are now considering. This apparatus, which I show in Fig. 30, is of considerable interest, as illustrating an attempt to use soft coal in the regular generator-superheater process, and to that end, in the superheater, instead of having the usual checker brick work, we find a series of thin partition walls, for superheating surface—the idea being to allow no lodging place for ashes or soot that might accompany the use of soft coal. Any such deposit, falling entirely to the bottom of each vertical division, where are handholes for cleaning, etc. The generator, also, is somewhat different, the air blast passing *down* through the coal

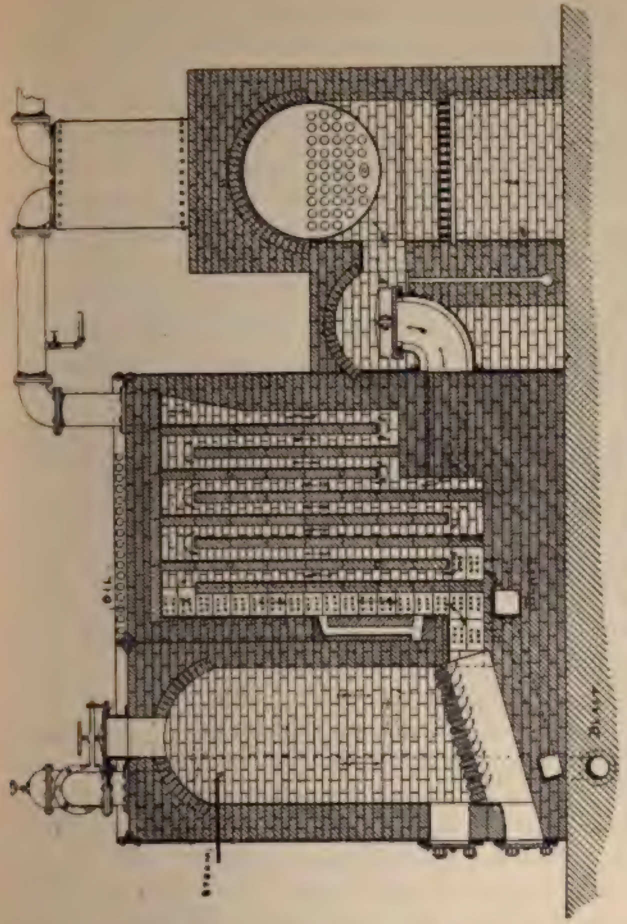

FIG. 30.—THE LOOMIS APPARATUS.

instead of up, as in the usual fashion. When a proper heat has been attained, steam is admitted in the generator, at the top, passes down through the coal, is decomposed, and meeting the oil for enriching in the intermediate chamber "B," passes on through the superheater, to washer, scrubbers, etc. While good success was claimed for this apparatus, it is a significant fact that, although the inventor has since erected numerous plants, he has not duplicated this style of works. These latter plants, however, have been more especially for the production

of a non-luminous fuel gas, in generators only, any portion of which, if desired for illuminating purposes, is afterward carbureted in retorts, in the manner of the preceding class.

The whole subject of fuel or non-luminous water gas, and the apparatus for its manufacture, not being within the scope of this paper, I shall not enter upon, but will leave to abler pens than mine, the description of the various apparatus and systems advocated by Messrs. Lowe, Strong, Evans, Rew, McMillin, Loomis, Humphreys, Clark, etc.

Now to what process have all these forms of apparatus which I have enumerated, dating back an hundred years, led up to, as the successful system of water gas manufactured to-day? Obviously, the answer to this is: That which has been most generally adopted. This, then, becomes not a matter of opinion but of statistics, and three lines will show it, viz.:—(Taken from the list of water gas plants appended.)

Number of retort process plants.....	9
Number of generator process plants, Section "A" ...	46
Number of generator process plants, Section "B"....	312

Undoubtedly it is the last type—and the great feature of this type which has so far outstripped the others—*is—by the use of an internally fired superheater*, the getting of all the necessary operations of water gas making into one compact apparatus, which, costing the least for erection, operated with a minimum of labor, and above all, by the utilization of heat previously wasted, has made a direct saving of heat, of energy, and of dollars. The successful apparatus of to-day is built upon these lines; appearing in a dozen different forms, differing as is but natural, in design, proportion and efficiency, according to the various construction, but all having the great point in common—of the use of an internally fired superheater (the invention of which, by T. S. C. Lowe, has been so strongly upheld by the late decision of Judge Wallace) this type of apparatus has been erected throughout the country, and with the greatest success.

Many localities I can indicate where it is superseding older forms of water gas apparatus, which have now almost ceased to be erected, and so completely is the generator-superheater

type the process of to-day, that while knowing of at least 25 new plants of the same, erected this season, I can scarcely find enough of the others to count. It is not to be wondered at. Compare it for instance with the other type of this class, where the blowing up the coal in the generators to incandescence, an enormous amount of heat is lost up the chimney, and absolutely wasted (a criminal offence in these days of high efficiencies) and then a second fuel account is started to carburet and fix the gas. Is it any wonder that a system which (leaving out all other questions of labor, repairs, convenience, etc.) combines these two operations in one, has so rapidly distanced the others?

I do not mean any disparagement on the one hand, or praise upon the other, of any particular apparatus, but I do mean, in contrasting the several *types*, that the generator-superheater system, all-in-one-apparatus, is pre-eminently the choice of those adopting water gas to-day. I am not here to recount the old arguments for or against water gas, to rehearse the efforts of those interested, to stay its progress, or to condone the "serpentine" methods which were used, unfortunately, at times, by both sides. "We are confronted with a condition, not a theory," and that condition is, that water gas is to-day one of the largest and most prosperous branches of the gas industry. Fourteen years ago there was scarcely a plant in the country; to-day, over 300 cities and towns, or nearly thirty per cent. of all the gas towns in America, have over 350 distinct plants, and the output of water gas constitutes, probably, one-half of all the gas made in the United States. Since 1886, or within the last three years alone, water gas has doubled—in that year there being less than 150 cities using it.

Look at the map yonder and notice how water gas, indicated by the red dots, has spread throughout the country. From Maine to California, from Florida to Winnipeg—we find it everywhere. Look at New York, with fifty water gas towns; look at Pennsylvania; out of 108 gas towns over fifty per cent. are water gas, I do not mean "auxiliary" plants, but out and out water gas, only three of these points making coal gas. But you say, Pennsylvania is especially well adapted for water gas from nearness to the hard coal and oil fields. Look then upon

Vermont—without a coal gas works in the State; upon Florida —where six out of nine gas points are water gas. Oil is the cheapest gas making material to transport to these distances. Look at Ohio, in the centre of the soft coal field. A few years ago there was scarcely a water gas plant in the State; to-day there are 20 and steadily increasing. In Massachusetts, with laws cleverly passed to prohibit it, a dozen plants are daily manufacturing it, and so on, from one end of the country to the other.

Now what is the cause of this wonderful growth to its present proportions? I answer, *the intrinsic worth of the system itself*. It must be so, or it would never have grown to its present position. The London *Journal of Gas Lighting* speaks of water gas as "Almost an ideal system." Certainly a method of manufacture, that occupies a minimum of floor space, uses a minimum of labor, and costs the minimum for repairs—a system of enormous capacity, that can be started into full operation at a few hours' notice, completely utilizing gas making materials of minimum bulk, having no residuals, and giving their highest candle powers, is *bound* to prosper. And when, in addition to the above, in a majority of cases, a direct reduced cost of gas in the holder, is added, a still more potent reason is seen for its adoption. Equally well is it adapted to the largest and the smallest works, for while the largest plants are in use in New York, Brooklyn, Boston, Philadelphia, Chicago, San Francisco, etc., and nearly every other large city, yet have I seen also a water gas plant of the smallest size, (in a town of 2,000 population, with no mills and but 1 1-2 miles of street mains), completely installed in an old church building 30x50 feet. The generator in the Sunday-school room, the holder in the auditorium, the oil tank in the pulpit, and a pipe shop in the organ loft. Although this plant burned down without insurance, yet the owner immediately rebuilt, for even on as small a scale as this, there was money in it.

Much as water gas apparatus has been improved since its beginning, its capacity doubled, the quality of gas made vastly better, the ability gained to use crude oils, tars and distillates, with entire success, likewise coals and cokes heretofore deemed impracticable, and the far better mechanical construction of the

apparatus, there is still ample field for the water gas engineer to work in. Details of design and proportion that are by no means yet agreed upon, the utilization of the highest degree of the heat of the escaping gases, in the more perfect heating of the incoming oils, steam, blast, etc , the perfect shaking grate, and the absolute utilization of all kinds of fuel, are problems as much yet to be solved as those to which the coal gas engineer looks forward in striving to perfect his bench, or to utilize his residuals.

I believe that these problems will be solved, and in the near future; that soft, or bituminous coal—the cheapest fuel in nearly every locality—which in the past has been the mainstay of the gas maker, will so continue to be; but will be used direct and completely in a water gas apparatus, and enriched with some form of petroleum. Regarding the future supply of this desirable commodity, I am neither prophet nor oil expert; however, from the very many places of its discovery—Pennsylvania, Ohio, New York, Tennessee, Texas, Wyoming, Colorado, California, Canada, etc., (to say nothing of the fields as yet undiscovered), and the great fields of Russia (beside which our own pale into insignificance) which are but awaiting a pretext to utilize the 1,300,000 gallon tank steamers already built, to lay their products at our doors—I believe that we need have but little fear of the oil supply question.

Until that millenium day of fuel gas, when, with mains and holders quadrupled, we shall be sending out unlimited quantities of an uncarbureted gas, or at least as long as we continue to make an illuminating gas, I agree with Dr. Walther Hempel, that "The water gas process is, without any doubt, one of the greatest inventions connected with the gas industry since gas was first made use of," and also believe, with the eminent chemist, Rudolph Wagner, that "water gas appears to be the illuminating gas of the future."

The subject is almost endless. My paper now is much beyond the length I contemplated, with many points but touched upon, and still more entirely omitted. I trust your patience has not been too severely tried.

In closing I would call your attention to the list of water gas towns to date, attached to this paper, which I have prepared

with some care, also to the list of reference papers consulted, which may be of use to the student; which papers form about the only, and largely unsatisfactory literature, upon the subject.

I also wish to herewith express thanks to numerous constructors of processes herein described, for their courteous replies to my request for information concerning the same, for this paper.

Before the discussion is opened upon this paper I would like to call the attention of the Association to the charts which I have placed on the wall. The first I have referred to in my paper. I think you will find it interesting as showing the distribution of gas towns throughout the country. My object in preparing that chart was to show any one who thinks that water gas does not amount to much in North America, or who thinks that water gas is confined to local districts, or who thinks that water gas has not grown to any great extent, that he is laboring under a mistake. I respectfully invite any such person to count the red spots on that chart. The red spots indicate companies which have adopted water gas wholly or in part; and the green spots represent all the coal, or wood gas, or whatever you please. The data is taken from "Brown's Gas Light Directory," which is about the only source of authority we have in such matters, coupled with information which I have already obtained. In this chart I call your attention to a little diagram which indicates the growth of water gas, by years. Each one of those spaces, from one side of the sheet to the other, represent one year. You will see that in 1858 the first water gas appeared—that of Sanders; and two or three plants were erected about that time. We find none others until 1863. Then there is one at Newark; and in 1868 we find the first plant under the Gwynne-Harris system. In 1873 the Lowe patent appears and from that date the Lowe plants were erected. Each one of these spaces indicate 50 companies. We will see from that date to the present time that there are over 300 companies formed within fourteen years, and that during the last three years alone the number has gone from 150 to 300, thus duplicating itself within three years. The proportional table given below indicates the number of plants which have been erected. The third line here indicates the substance of my

paper, which is this: That the superheater apparatus is the apparatus for to-day. That is shown by statistics and indicated graphically by these three lines at the bottom. On such a subject as this it is very difficult to get absolutely correct information, and I presume one or two mistakes are made in the list of water gas companies; but I think that it is correct as a whole, and I believe that the percentage of error will be found inside of one per cent.*

Discussion.

THE PRESIDENT—The paper of Mr. Shelton is a very comprehensive presentation of the progress and present condition of water gas in this country. I hope gentlemen wishing to ask any question, or who have any remarks to make will now do so.

MR. SCRIVER—I presume that the cost of oil differs in different localities the same as coal.

MR. SHELTON—Undoubtedly.

MR. SCRIVER—The price must certainly enter into the question. The company that I represent manufactures coal gas entirely, and by comparison with the Toronto Gas Company, which manufactures part coal and part oil gas, we find our results to be more satisfactory than those at Toronto, in figures of dollars and cents.

MR. SHELTON—That is a question that one would have to go into very fully, and take all the points into consideration, before arriving at a definite conclusion.

MR. SCRIVER—In discussing the cost of coal gas you have to take into consideration the sale of your residuals; and that is how we beat the Toronto company. We get a very good price for our coke, and for our other residuals—coal tar and ammoniacal liquor. So that, taking into consideration the prices we get for our residuals, we beat oil gas all to pieces.

MR. SHELTON—Of course it is a question of dollars and cents. If a company is so situated as to get coal cheaply, and

* See Appendix for list of Water Gas Literature.

can obtain high prices for residuals, coal gas may be less expensive than water gas; but in a majority of places I think it is not so.

Mr. Pearson—I did not catch all that Mr. Scriver said. I understood him to say that he was making a cheaper gas in Montreal than we are in Toronto. I do not wish to enter into any personal discussion, and I will merely say that Mr. Scriver can get his coal at Montreal for about half the price that we can buy our coal in Toronto. That is a very important consideration. I will say to Mr. Scriver that we have been making about half and half coal and water gas with our old coal gas works. We have been making gas by the old Lowe gas process in Toronto, and we contemplate making a change. I am quite aware that we might make gas a good deal cheaper by that process; but I do not know exactly how he makes out that his gas is cheaper; I do not accept that, however, on his mere statement.

Mr. Scriver—What I have stated is entirely correct, although Mr. Pearson may forget it at the present time. I think at the time we made our comparison Mr. Pearson was making gas almost entirely from oil.

Mr. Nettleton—We are drifting somewhat away from the paper. Speaking for myself I want to say that the paper and its teachings have been a great surprise to me. I had no idea that water gas had grown to the enormous extent stated in the paper and represented on the chart. I think that all of us must realize that Mr. Shelton has gone to an enormous outlay of labor in collecting all these statistics; and it seems to me that a hearty vote of thanks are due to him for preparing such a paper as this. Further than that, I know Mr. Shelton so well that I am confident he does not make the statement that he thinks he is within one per cent. of being correct, or that the error is not more than one per cent., unless he is very sure that it is so. I am confident that this paper will go down as being an absolutely reliable paper of reference on the subject of water gas down to the present year. I move that a hearty vote of thanks be given to Mr. Shelton for his very able paper on water gas. I do not intend by this motion to cut off the discussion.

Mr. E. C. Brown—Mr. Nettleton has stated what I had intended to say, and so I will merely second his motion. [The motion prevailed.]

The President—We will next listen to the reading of our last paper, by Mr. Charles L. Rowland, entitled

GASHOLDERS: THEIR CARE AND OPERATION.

Somewhat more than a century ago, when gases first began to attract the attention of scientific men, the gasometer or holder was invented by the great French chemist, Lavoisier. Owing to this invention, the utility of gas for lighting purposes became practicable, for previous to this the only means for the storage of gases has been bladders. The most ancient holders were square or rectangular in form, and designed as a measurer of gas for experimental purposes only, hence the term gasometer. Gradually, however, as gas became a commercial article, and has finally proved itself the light of the Nineteenth Century, the gasometer developed into a reservoir for the mere storage of gas, and as now used, the simple name of gasholder is more appropriate.

These holders, in their early days, were made in one section only, and operated in wooden tanks. In 1814, the English government was strongly urged to restrict gas companies from constructing holders exceeding 6000 cubic feet capacity; since then, however, the dimensions of gasholders have increased at a marvelous rate, especially so during the last fifteen years; and nowhere are they built on so large or grand a scale as in the same country where the restriction was sought. The necessity for increased storage capacity at a low cost, brought out the idea of building holders of more than one section, by use of the hydraulic cup and seal. This method is commonly called the telescopic system, and has proved to be entirely successful, demonstrated as it is by the practical operation of the enormous three and four sectioned structures of the present day. Thus, we now find gasholders consisting of two types, viz.: the single lift, and telescopic; the latter type embracing all made in more than one section or lift, and to distinguish them are called, couple, triple and quadruple lifts.

One of the most essential features in the operation of the holder, whether single lift or telescopic in character, is that it shall work smoothly up and down the guides with as little friction as possible, without getting out of level to any appreciable extent.

Stability of Holders :—Let us consider the holder as a vertical cylinder, and see why it should be unstable and liable to get more or less out of level; assuming the center of gravity to be the pivotal point. If the cylinder has no top, its center of gravity (assuming its sides to be of equal weight throughout), would be in the centre of its length or height, and it would of course be in equilibrium. Now, then, we close the top end and in so doing add as much or more weight at the top than we have in the sides, the result being our cylinder is top-heavy, and would overturn unless supported and held in position. For instance, a gasholder of ordinary construction, 100 feet diameter and ten feet height of section, would be quite out of proportion. The cylinder in this case being too short for its diameter, would be quite unstable. There would be about twice the weight in the roof that there is in the sides, and the center of gravity in consequence would be very high, being close under the center of crown. Such a vessel would prove extremely troublesome, the natural sequence being that it would be ever ready to invert upon slight provocation. The operation, therefore, of a holder, depends largely on its proportions and structural character, a knowledge of which should be possessed by those who have the structure in charge, in order to know the cause of difficulties which may occur in its operation from time to time. It often happens that more pressure is required than the natural weight of the holder will give, and as avoirdupois is all that is needed to obtain the desired pressure, the first impulse is to load the roof. It may perhaps be the case that the holder is of shallow section which already is overloaded at the top, and if its weight is to be increased, it should be added at or near the bottom of the section as possible. When the necessity of this added pressure is imperative, it is sometimes unwisely decided to obtain it in the easiest manner, and in consequence the operation is ofttimes attended with disastrous results. I would, therefore, caution those in

authority, to look well into the matter before deciding how increased pressure shall be obtained. To the want of proper precaution under the above conditions may be ascribed the many instances where gas companies have sustained serious damage to, and in many cases the total loss of, a holder.

Hydraulic Seal.—In all telescopic holders the hydraulic seal must be cared for, the old style of construction being as shown by Fig. 31. Although the cup rises from the tank filled with water, there is always with this form quite a loss of the seal, due to the fact that as soon as the gas pressure is exerted upon the inner portion of the cup, the water at A is depressed as many inches and fractions thereof as there is gas pressure, causing an equivalent amount of water to overflow at B, the top of the section coupled, thus greatly diminishing the depth of the seal. The more modern and improved method is shown by Fig. 32. And although as will be seen the only difference in construction consists in carrying the dip sheet some six inches or more above the top of the dip; nevertheless, it is an important feature, as it forms a dam which prevents the overflow and consequent loss; the water in the latter case being depressed equivalent to only one-half the pressure at A, and rising to the same extent at B and confined by the dam, thus reducing the percentage of loss of seal one-half. There is also an important difference in the operation which is much in favor of the latter style. When the water accumulates from steaming the cup in the former method, it overflows the dip, and in cold weather forms large masses of ice on the side of the section; while the latter style will, if the dam be sufficiently high, simply confine the water while it rises at both A and B, and until the cup overflows at A, inside of the holder, as in Fig. 33, at which time the efficiency of the cup is complete.

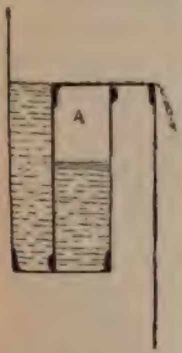

FIG. 31.

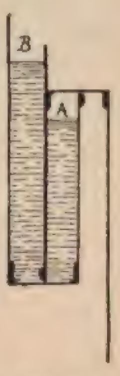

FIG. 32.

FIG. 33.

To prevent the water in the cup freezing, steam pipes should be carried up a portion of the height of the guide frame and connected with one or more jets in the cup, by means of flexible steam hose, the jets being located in the cup a few inches under the surface of the water, and supported in a horizontal position, so that the steam upon being turned on, will cause the water to circulate completely around the holder.

The cups are quite apt to be the receptacles for small stones and other missiles, especially when located near the public thoroughfare and exposed to the mischievous small boy of the neighborhood. They should occasionally be examined by feeling into them when they are near the surface of the water, and nearly high enough to engage with the next outer section.

Care During Storms.—I have frequently been asked if it is not well to lower the holder during high winds. At first thought this would seem a rational thing to do, and for a single lift holder it would be quite proper. For telescopic holders, however, it is not wise; the better way being to raise them till the outer section is cupped, for coupling the two sections or three, as the case may be, doubles or trebles the length of the cylinder, thereby lowering the center of gravity, and otherwise causing greater stability. This increased stability, caused as it is by the additional length of the cylinder, more than compensates for the greater surface exposed to the force of wind; of course, this action can be taken only when two or more holders are in use. The same method should be employed in caring for a holder in times of heavy snow fall. During such storms the men should be employed in clearing the roof, the precaution being taken to equalize the working force, so that like parts of the roof will be cleared at the same time, keeping the holder as nearly as practicable in equilibrium, care being exercised to throw the snow well away, so that in falling it will not lodge in the cup or tank.

Tank.—The main feature in the care of the tank is that the

water be kept up to the proper level, and that stones and other solid matter be prevented from falling in, which might in time be the cause of serious injury. The overflow should be frequently looked after, and kept free and clear.

Counterweighting.—Where the local conditions make it feasible, on general principles it is well to eliminate all counterweighting, but as specific statements under this head would open the door for considerable discussion, and as this feature may be considered as relating more properly to construction, I refrain from going into the matter in detail, but will simply state, where counterweights are in service, and it is desired to discontinue their use, it would be well to remove from the entire structure all the weights and counter gear.

Leaks.—All leaks, however small, should be promptly attended to as soon as detected; let them be repaired by a competent man, and furthermore one who will not as far as appearances are concerned, convert a new holder into an old one by injudiciously putting a patch here and another there, when all that is really needed is good judgment and the caulking tool.

Painting.—No precise rules can be laid down for determining how often a holder should be painted, as some climates are much more severe in their effects upon the painting than others, it being necessary in some localities to paint the holders every year, while in others a good coat in two or three years will suffice; but when it is done let it be thoroughly and well done, and no half way work about it. The mere coating the holder with the paint is the least part of the job when the work is done as it should be. Before painting, the sheets should be carefully scraped, removing all blisters and scales, leaving a good service for the new coat to adhere to. If the painting is done without such a previous preparation, the objects ought, *i. e.*, the preservation of the structure, will not be attained. Undoubtedly the new coat of paint would greatly enhance its appearance, but oxidation and decay would be constantly doing their work under the cover of good looks.

Discussion.

MR. BUTTERWORTH—I would like to ask Mr. Rowland how he would stop small leaks in the seam of a holder?

MR. ROWLAND—The small, ordinary leaks that come in the seams of holders should be stopped with a caulking tool, as far as possible. It can generally be done, unless the iron is pretty well decayed. Almost any competent man can do a thing of that kind.

MR. GLASGOW—I agree with Mr. Rowland about raising the holder when you see a storm coming up, but my ideas of doing it are different from his. I want to raise my holder because I naturally want to have sufficient gas on hand ready for the increased consumption during the darkness caused by the storm. Of course it is very desirable to have the center of gravity below the geometrical center of the holder, but I do not see how to accomplish that by raising the holder. When you raise the holder you have the application of the wind higher up, and you have a larger surface exposed to the wind. I am unfortunate enough to operate a 500,000 holder which has to be watched every time it cups. This holder was constructed for the Kansas City Gas Light and Coke Company in 1876. When it was built there were blocks laid, upon which the sections were built (in size 6 by 6, and about 18 inches long), and when the holders were filled those blocks were not extracted from the inside. Shortly after I went to Kansas City I was walking around the holder one day, and I found that it was very badly canted. One side was bulged in badly. This canting occurred a second time, and at that time the holder was so badly damaged as to make it impracticable for us to let it down; and we did a job of repairs upon it which seemed to me almost impossible when I first looked at it. The channel of the outer section was twisted so badly that, after we had it uncupped, it was tilted and the spring remained in it at an angle of 25 deg. horizontally. Inside of the cup the sheet was torn all to pieces, and the outside sheet had a crack in it six feet long, where the channel had bent out and kinked it in. I will not describe how we fixed it, as I suppose each of you know it better than I can state it; but we did fix it, and after that we had no further

trouble. I do not think that holders occasion a great deal of trouble in their care and operation, provided they are properly constructed. In a holder that is being erected under my supervision, the foreman of the iron works inquired how much out of plumb the walls were. He was told that they were a quarter of an inch out in the worst place. He expressed a great deal of surprise and satisfaction, and said that if they had been three inches out it would have made no difference, as the wall plates could have been easily sprung in to conform. He said that frequently they were five or six inches out, but that if they could get the girders on there was not much trouble in tilting the columns over, and it did not give any great trouble in construction. Of course when a man goes out like that, and expects to put up a large holder, and the superintendent permits the work to be done without supervision, it would be no wonder if a good deal of trouble was occasioned, and that the care and operation of the holder give a great deal of anxiety.

I once had a holder which I used to go around every day looking for leaks. It was such a shell that it had to be coated periodically with tar—which I considered a very bad thing to put on a holder—and water blisters had accumulated under the tar and rusted the holder and it was a mere shell in many places. I could see holes as large as pin heads, and I could run my finger at places into the shell. Then I would stop it up temporarily with something that I always carried in my hand when I went round the holder. I would put a patch on it. We found no difficulty in patching up such a leak anywhere if we could get at it—by a plan which may be common and universal, but which was original with me at the time. And that is simply having an iron saucer, and a rectangular shaped nut or screw, probably three inches long, three-quarters wide, and a quarter of an inch thick. We would drop that inside of the hole, with a string tied around the top, then would fill up the saucer with a preparation of red litharge and glycerine, or any other good setting stuff, and draw the string through the centre of that and then put the screw in and clamp it up tight. In one day we put on a dozen of those on places where you could put your finger in. I am glad to say that that holder has since been renewed.

MR. ROWLAND—I would say that in speaking of coupling the holder I have reference to the safety of the holder during a gale. The holder after coupling, forms a longer cylinder than before coupling. In the case referred to by Mr. Glasgow a new holder was undoubtedly needed.

MR. GLASGOW—I do not see how the center of gravity is lowered with regard to the geometrical center of the holder.

MR. ROWLAND—But the center of gravity is lowered.

MR. GLASGOW—Relatively to the exposed part. It may come down from the top, but it travels up from the bottom.

MR ROWLAND—To illustrate: We will assume that the center of gravity is about *here*, (making sketch) in proportion to its height. Now, when we double the length, instead of the center of gravity being up here, it is away down here.

MR. GLASGOW—That is just what I say. It is lowered from the top but it has come up from the bottom.

MR. ROWLAND—It is much nearer the bottom than it was before. I could illustrate to you by a diagram.

On motion of Mr. Nettleton, a vote of thanks was given to Mr. Rowland for his interesting paper.

THE QUESTION BOX.

(1) "*Can Electric Lights be Sold at a profit in Towns of 8,000 Inhabitants in Competition with Gas?*"

THE PRESIDENT—If any of our members have had experience under such conditions we would like to hear from them.

MR. BOARDMAN—I am interested in a gas company which is operating an electric light station in a town of about that number of inhabitants; but I do not know as I am prepared to answer the question whether it will pay in competition with gas. We certainly are in competition with ourselves. The electric light is sold in competition with the gas which we sell ourselves; but as we have the regulation of the price of both, it is hardly fair to say that there is competition. In this particular

case we do make money on the electric light. I will state that we charge $2 per thousand for our gas (with ten per cent. off for prompt payment, or $1.80 net); and while we are not using the incandescent light from an incandescent circuit—we are using what is called series lighting—we charge for 32-candle power lights $3 per month, and for 65-candle power lights $5 per month. The arc lights we sell at from $10 to $12.50.

MR. GRIBBEL—Is that an all night circuit?

MR. BOARDMAN—The street lighting is an all night circuit, but the other is by the moon. For our 12 o'clock lights for stores we get $12.

THE PRESIDENT—Perhaps Mr. Prichard can give us some information on this subject.

MR. PRICHARD—I think it is entirely dependent upon local circumstances. In one company with which I am connected we have had about the same experience that Mr. Boardman speaks of, and have made it a commercial success.

(2) *"Where Should a Gas Company's Ownership of Service Pipes Terminate—at the Street Curb, Lot Line, or the Meter?"*

MR. TABER—I would like to answer that question, and to answer it pretty liberally. I think a gas company ought to supply its own pipe to the meter; and I say so advisedly, because in these days of sharp competition, if you are going to undertake to so run a business as to make money on these minor details, you will lose your trade. I am perfectly satisfied of that in my own judgment, because I have seen it tried that way in the matter of coke. We used to sell our coke and the buyer would have to hire a horse and wagon to cart it, and then hire a man to put the coke in. Under these circumstances we never sold any coke worth speaking of. After we bought a horse and wagon of our own and employed a man to put the coke in, we could sell what we pleased. I think that in these days, when competition is so great with electricity and water gas, that we had best be a little less cautious and a little more liberal in our expenditures. Of course, if the service pipe is a long one it would be well that the parties should pay for it; but in most of our smaller towns the gas company can

well afford to pay for the four or five feet of service pipe, rather than try to collect anything for it. In our locality we find that that plan works decidedly the best.

Mr. Boardman—There is another very strong reason in these days why a gas company should own its own services. Besides being able to put in such pipes as they choose, in order to properly protect themselves in case of leakage, they can also say when an opposition company sets up, "We own our services, and if you are going for our patrons you must put in your own services." Then they will have to dig up the sidewalk again, which will prove very obnoxious to the householder, and he will very quickly give you a chance to talk with him after the opposition has seen him rather than have his sidewalk torn up. I would advise it by all means, whether it is a short service or a long one, that a gas company own its services and its meter connections.

Mr. Nettleton—Mr. President, have you any objection to stating what the custom is in Providence?

The President—We own our services, run all our services to the meters and set the meters without any charge to the consumer.

Mr. Butterworth—I have here a list of ten moderate sized cities of the country where they dispute that point as to the ownership of services. Only three out of the ten run their services free, even to the lot line; six of the others run to the curbstone; and one runs the services free only twenty feet from the main.

(3) "*Is it economy to use illuminating coal gas for fuel under boilers, with price of soft coal at $4.50 per ton? If it is, what kind of burners are generally used, and about what do same cost per set for furnace? If not, why not?*"

Mr. John Young—In reply to that question I would say that everything depends upon the price at which you can buy gas. If you can buy it for something like twelve cents a thousand feet it might be worth while to try the experiment. Coal at $4.50 per ton would be a little over 17 cents per bushel. A bushel of coal will develop a little over one million heat units,

and it would take about 1,300 feet of illuminating gas to produce the same number of heat units. From that data the calculation can be made as to whether it would be more economical to use coal at $4.50, or coal gas. It depends entirely upon the price that must be paid for the gas.

(4) "*What proportion of the total is the present day consumption of gas in an average American City?*"

MR. BUTTERWORTH—I do not know whether Columbus, Ohio, would be considered a representative American city or not, but I know what our day output is there, and what proportion of the total it is; and I can describe the city. It has 100,000 inhabitants; it has a fair quota of gas stoves; it is built on rising ground; it has no pall of smoke resting upon it; its streets are broad, and the buildings are not particularly high; and it has a large manufacturing interest for a State Capital. I am not booming the city for the World's Fair at all. The output there from six A. M. to six P. M. is about 22½ per cent. of the total.

THE PRESIDENT—Have you any idea what number of gas stoves you have in use?

MR. BUTTERWORTH—I have not.

(5) "*Is it wise to make a special discount on gas used for cooking and heating?*"

THE PRESIDENT—I think there are some companies making special rates for gas stoves, or for gas used for mechanical purposes.

MR. SCRIVER—I may say a little something on that subject. I can say a good deal, but time would not permit. I think that our company (Montreal) was the pioneer company to make a different rate for gas stoves, gas engines and for manufacturing purposes. It is now about ten years since we commenced the introduction of gas stoves. We then made up our mind that it would be an advantage to our company to make a reduction. We were then selling gas at $1.70 for all illuminating purposes, and we made the price of gas for cooking stoves $1.20. The price to-day for illumination is $1.50, and we are selling gas for

cooking and heating purposes for $1. We think it is a very great advantage to us. It might not be an advantage to every gas company in America, but we are pretty clearly of the opinion that for ourselves it is a very great advantage. At the present time we have about 3,000 gas stoves in use. Our consumption for gas stoves, and for heating and for manufacturing purposes, amounts to about one-fifth of our make. The revenue derived from the gas stoves for these purposes is about one-fifth of our whole revenue. We calculate that we sell for these purposes ninety million feet of gas per annum. That it is a very large business of itself, and we would not like to be without it. The average price of gas with us would be about $1.25. We think we can manufacture gas and sell it at that price and make a handsome dividend or profit besides. We think that it pays—and I suppose that is the principal question. We think it pays very handsomely at these figures, in fact I know that it does. Other considerations might enter into this question, as, for instance, the consideration of philanthropy; but I do really think that we ought to be philanthropic. I think that we ought to be generous, and treat our customers in a liberal and generous way. That is a very great point to be gained. It is commonly supposed that gas companies are very selfish, and since the introduction of the electric light, I believe it is our policy, more than ever before, to be liberal and generous to our customers. We, therefore, have made this reduction, and treat our customers in this generous manner. Of course you will easily understand that to manufacture the ninety millions of extra gas that we are making, over and above what we would manufacture without this business, causes us to employ an extra number of men. It also means to us the carbonization of about 9,000 tons of coal extra, and that means employment to a large number of men in various ways, and it means the support of a large number of families. I would not like to take up your time further in expanding this consideration. I do not know that it is of very great interest to you, but still I mention these things in order that we may fully understand that we should be generous and philanthropic also. (Applause).

MR. PEARSON—We have been selling gas at a reduced price

for the purposes which have been alluded to, during a period of about eight years. I am satisfied that selling it at a reduced price has very greatly increased the consumption. Our selling price for gas, when we began to sell it cheaper for heating purposes, etc., was $1.50; and we reduced the price for those purposes to $1. Our present selling price for illuminating purposes is $1.25, coming down to $1.10, and we have kept the other price at $1. I find that consumers are very ready to take gas at $1, but when, under certain circumstances, we talk of charging $1.25, because we did not think that the consumption was large enough to warrant such a low price, our consumers strenously objected. During the past year the gas stove companies in Toronto have sent out at least a thousand gas stoves and heating apparatus, and I believe that they could not have sent out one-half that number had we not reduced the price. I think, moreover, that we can afford to sell gas for those purposes because it is very largely a summer consumption, and a day consumption, and by that means we utilize our plant more fully, and during a greater portion of the year than we otherwise would do.

Mr. Nettleton—I would like to ask Mr. Pearson for what purposes he sells gas at $1.

Mr. Pearson—For cooking, heating, power, and for mechanical purposes where they burn enough—such as for soldering irons, jewelry stores, and for anything except for illuminating. We have a separate meter and do not charge any rent for it. We lead pipes from the other meter to where the gas is to be used. They simply pay the expense of the piping from where the pipe enters the house to where the meter is. I might add that the amount of gas that we are sending out for those purposes is about thirty million feet, and we are getting paid for four hundred million feet for all purposes.

The President—Do you know how many gas stoves you now have in use?

Mr. Pearson—I have no memorandum of the number with me. We have a good many gas fires as well as gas stoves. I think altogether, of gas fires and gas stoves, we have about

1,500. And besides that we have a great deal of gas used for mechanical purposes which does not come under the low price, because they have not got separate connections. I am quite certain that we send out thirty million feet of gas for those purposes.

MR. SCRIVER—The reason why our consumption is so large, and why we have so many stoves out, and why we pay such attention to this branch of our business, is that we manufacture our own gas stoves, and we sell them to our consumers at a very small profit. We fit them in their houses free of charge. We do not charge them anything for attaching to the meter, nor do we charge for the pipes leading from the service to the gas stoves, but we do charge a small annual rental for the meter.

(6) "*Is the scheme of introducing air into gas for the purpose of revivifying the iron a success?*"

MR. BUTTERWORTH—At Columbus, Ohio, we introduce a little air into our gas for the purpose of prolonging the life of oxide in the boxes, and we find it a great aid. We have a very poor local coal, which has probably almost as much sulphur in it as any coal in the market, and we find that the introduction of air is a great relief when using that coal. One-half of the coal is of that kind. The operation has not been conducted with a view of collecting any accurate data that would be of any great value from a scientific point of view, but only in a practical way. I do not know exactly what proportion of air we use. At first we tried to regulate and measure the air by passing it through an ordinary sixty-light meter, but like all other meters registering gas it got to going too slow and we abandoned it. Now we simply use it by drawing the air through a sealing of one-tenth of an inch of water. We watch it closely, and find that we keep our candle power up to 18 or 19 by using from four and a half to five per cent. of cannel coal.

MR. ROBERT YOUNG—Do I understand Mr. Butterworth to say that he has no means of ascertaining how much air he introduces into the gas?

MR. BUTTERWORTH—I am not prepared to say.

MR. ROBERT YOUNG—Nor how much it diminishes the illuminating power?

MR. BUTTERWORTH—Except by the fact that we keep it up to 18 or 19 candle power by using $4\frac{1}{2}$ to 5 per cent. of cannel coal. I do not think that we introduce more than one per cent. of air.

(7) "*What progress has been made this year in the matter of regenerative furnaces?*"

THE PRESIDENT—I think that Mr. Weber will answer that question.

MR. O. B. WEBER—I do not know what actual progress has been made except from the fact that we have introduced more this year than we did last year. As against 80 last year we have this year introduced 138, and they have been used as far North and West as Victoria, B. C., and as far South as Venezuela, S. A.

THE PRESIDENT—This question is perhaps a little indefinite. The writer does not state whether he means progress in the kind of furnace used, or in the number that has been introduced. Perhaps he means both.

MR. O. B. WEBER—As to that I may say there has been an improvement in the construction of the furnace, in the way of making it more lasting; and we have also been able to reduce the formation of clinker. In fact, we are able to get along without any clinker at all. They have also been improved in the way of more readily controlling the heat. Beyond that we have made no improvement; but, of course, those are very essential, and have brought the furnace to the point of success.

(8) "*How should fire brick and tiles be laid—wet or dry?*"

THE PRESIDENT—I think Mr. Weber can answer that question also.

MR. O. B. WEBER—I should answer it by saying that they should be laid neither wet or dry, but dipped, so as to allow the mortar to adhere more easily and stronger. Unless fire brick is laid in that way there is a strong tendency for the mortar to scale off; and, therefore, we dip our brick.

MR. BREDEL—If the brick is largely silica it has to be laid wet; on the contrary, if the brick is largely aluminum, it has to be laid dry.

(9) "*What composition of gas will give the highest illuminating power when burned with a common fishtail burner passing 5 feet per hour, and convert all the carbon into* CO_2*?*"

MR. ROBERT YOUNG—I would answer by saying a gas containing the largest amount of hydrogen and the smallest per cent. of marsh gas. The percentage of hydrogen and carbon would be the same in both cases.

(10) "*What specific gravity of oil will yield the greatest amount of gas with the highest illuminating power?*"

MR. ROBERT YOUNG—I think the oil with the lightest specific gravity that you can find will give the highest illuminating power. I would like to hear some discussion upon that point, as it is a very important question in view of the large amount of water gas used.

THE PRESIDENT—I think Mr. Rusby can give us some information.

MR. RUSBY—I hesitate to say anything on the subject, but my experience in water gas, with crude oil and heavy oil, has been very successful; and I have always been led to believe that the greatest amount of illuminating power could be obtained from oil of the highest specific gravity. I have heard of figures which rather led me to the opposite belief. But until I have had a greater amount of experience, or have heard some figures quite different from those which have been given me, I shall have to adhere to my present opinion.

MR. MCELROY—I would say that oil of the highest gravity is the better oil. I was using for a considerable length of time the lightest crude oil that could be had. It bears a premium now of 25 cents—that is when ordinary oil is $1 per bbl. it sells for $1.25. I find that naphtha at $3.75 is cheaper than oil at $1.25. I use naphtha of from 68 to 70 gravity.

(11) "*What chemical change takes place when a liquid hydro-*

carbon is exposed to a high temperature and made into a permanent illuminating gas?"

MR. PRITCHARD—I think that the compound would be broken up by the deposition of carbon, and that there would be more hydrogen than carbon remaining

(12) "*What economy is there in using naphtha at 4 3-4 cents per gallon as an enricher, instead of good cannel coal at $7 per ton?"*

MR. LANSDEN—It depends upon what process and apparatus you use, and how you handle your naphtha. In some apparatus it is very much cheaper. I think it is cheaper to do it by simply putting a pipe into the retort—with cannel at $7.

VOTES OF THANKS.

THE PRESIDENT—We have no further business on the table. Has any member any business to bring up?

MR. LANSDEN—I wish to move a vote of thanks to our worthy Secretary who has so admirably arranged the papers and carried out everything pertaining to his duties. Although we have been deprived of his services a part of the time, I wish to move a hearty vote of thanks to him.

THE PRESIDENT—It gives me pleasure to put that motion. There is hardly a member in the room who realizes the amount of work done by our Secretary, unless he has had occasion to fill a similar position. The work done by the President is mainly done here at the meeting, and amounts to nothing at all as compared with what is done by the Secretary. [The motion was unanimously carried.]

MR. RAMSDELL—I desire to make a motion which I am sure will meet with a hearty response, which is that a vote of thanks be extended to President Slater for the able and efficient manner in which he has presided over our meetings.

[The motion was put by Mr. Harbison, and carried unanimously by a rising vote.]

EIGHTEENTH ANNUAL MEETING

OF THE

AMERICAN GAS LIGHT ASSOCIATION,

HELD AT

DE SOTO HOUSE, SAVANNAH, GA.,

OCTOBER 15, 16 AND 17, 1890.

FIRST DAY—MORNING SESSION.

The eighteenth annual meeting of the American Gas Light Association was called to order, in the De Soto House, Savannah, Ga., on the morning of Wednesday, October 15, at 9:30 A. M., by the President, Mr. Emerson McMillin, of St. Louis, Mo.

WELCOMED BY THE MUNICIPALITY.

Mr. David Douglas, President of the Mutual Gas Light Company of Savannah, stated that the Mayor, Aldermen and others of the city officials were in waiting for the purpose of welcoming the Association to the city. Thereupon, Mayor Schwarz, Aldermen Bailey, Parson, Meyers, Reed, Nichols and Falligant, Clerk of the Council, Rebarer, City Marshal Wade, and the Hons. Robert Falligant and A. P. Adams entered the room and were introduced by the President.

MAYOR SCHWARZ—As the Mayor of Savannah I have come to tender you the freedom of the city, and I will call upon the Hon. A. P. Adams to address you in my behalf.

HON. A. P. ADAMS—My friends, for so I would address you —let it be understood at once that you are our guests and are

Emerson McMillin

ur friends. I do not feel that I speak to strangers, and so I hall not speak in purely conventional phrase, nor in the formal anguage of cold and distant courtesy ; but, in behalf of this municipality that I am permitted in part to represent, and in behalf of the citizens of Savannah, I greet you. I salute you with the greetings of affection, and to every member, friend and attendant upon this Association I extend a hearty and a heartfelt welcome. (Applause.) We know, sir, the high character of your Association, and the worth and distinction of its representatives as they come to us from every section of our beloved Union (Applause), and from the great Dominion which is our near, and our very dear, neighbor. (Applause.) We feel honored by this presence; and you have aggrandized this honor, if you will permit me to say so, by the presence of so many brilliant, accomplished and graceful women, who shall be the fair, fond and special guests of the occasion. (Applause.) This Forest City of ours is beautiful to our eyes. Her sentiments and her traditions are dear to our hearts. We trust that here you will find that which will entertain and interest you, and will render all the incidents and reminiscences of this visit memorable and enjoyable. And, above all, do we fervently hope that in the social intercourse and amenities that will follow there will be laid foundations of mutual sympathy and regard, and of mutual friendships, to be augmented by time and form an enduring contribution to the joy and the happiness with which may ever your lives be fraught. We beg you to remember that while you are here you are at home. This city is yours. Our homes are yours. Our hearts are yours. Come, enter, and take possession. (Applause.)

President McMillin—All those who would return to the Mayor, to the speaker, and to the Board of Aldermen, their very sincere thanks for this reception, and extend to them the courtesies of the Association, and seats in this convention, will please rise to their feet. (All rose.) Mr. Mayor and gentlemen, we shall be pleased to have you take seats with us at your convenience.

The American Gas Light Association will now come to order for the transaction of business.

Under our rules the first business in order is the reading of the minutes of the last meeting.

On motion of Mr. Baxter, the reading was dispensed with.

APPLICATIONS FOR MEMBERSHIP.

THE PRESIDENT—The report of the Council upon the applications and transfers of membership is next in order.

The Secretary read the following report:

SAVANNAH, GA., Oct. 15, 1890.

To the Members of the American Gas Light Association—

Gentlemen:—The Council having approved of the following applications for membership, respectfully submit them to the Association for action.

Active Members.

W. R. Addicks, Engineer Bay State Gas Company, Boston, Massachusetts.

*F. P. Addicks, Treas., Boston Gas Light Company and Bay State Gas Company, Boston, Mass.

*J. F. Aldrich, Gen'l Manager Mutual Fuel Gas Company, Chicago, Ill.

*J. Buckman, Manager, Bristol Gas Light Company, Philadelphia, Pa.

*C. D. Blauvelt, Sec'y and Supt. Gas and Electric Light Company, St. Augustine, Fla.

*C. R. Collins, Engineer Titusville Gas Company, Philadelphia, Pa.

*J. A. P. Crisfield, Assist. Supt. and Sec'y, Mutual Gas Light Company, Savannah, Ga.

*Robt. M. Dixon, Engineer Safety Car Heating and Light Company, also Engineer Pintsch Gas Compressing Company New York, N. Y.

*J. M. Daniels, Supt. and Agent Columbia Gas Light Company, Columbia, S. C.

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*Present at this meeting.

R. F. Fitz, Supt. Elgin American Gas Company, Elgin, Ill.

W. S. Humes, Sec'y Gas Company, Altoona, Pa.

*C. S. Hammatt, Supt. Citizens Gas and Electric Company, and Jacksonville Electric Light Company, Jacksonville, Fla.

J. T. Herron, Supt. Citizens Gas Company, Buffalo, N. Y.

*L. L. Kellogg, Supt. Gas Light Company, Sioux City, Ia.

Wm. B. Miller, Supt. Cartersville Improvement, Gas and Water Company, Cartersville, Ga.

Henry Mactier, Chief Engineer Metropolitan Gas Light Company, Elizabeth, N. J.

*Benj. F. Macdonald, Sec'y and Treas. Consumers Gas Company, Newburg, N. Y.

*Jas. S. McIlhenny, Assist. Supt. Gas Light Company, Washington, D. C.

F. McKiege, Sec'y Standard Gas Light Company, New York, N. Y.

E. R. Phelps, Treas. Citizens Gas and Electric Company, White Plains, N. Y.

Thos. Ringwood, Prest. Ilion and Mohawk Gas Light Company, Ilion, N. Y.

J. J. Russell, Supt. National Gas Company, Sheboygan, Wis.

*W. L. Williams, Supt. U. G. I. Company, and Peoples Works, Paterson, N. J.

*J. W. Wilcox, Supt. Macon Gas Light and Water Company Macon, Ga.

*C. F. Zeek, Supt. Gas Company, Pensacola, Fla.

*J. W. Gwynn, Supt. Gas Light and Fuel Company, Bucyrus, Ohio.

William J. Winegar, Prest. Gas Light and Fuel Company, Palatka, Fla.

Chas. J. Hayes, Supt. Gas Light and Fuel Company, Palatka, Florida.

*Wm. S. Bowen, Assist. Supt. Gas Company, West Chester, Pa.

*R. M. Searle, Gen'l Foreman, 44th street station, Consolidated Gas Company, New York, N. Y.

*John Gimper, Manager Gas Company, Leavenworth, Kansas.

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* Present at this meeting.

Associate Members.

*Jerome Croul, Vice-Prest. Gas Light Company, Detroit, Michigan.

W. S. Essick, Sec'y Jones Meter and Stove Company, Royersford, Pa.

*S. F. Hayward, with Connelly & Co., Mfrs. Gas Apparatus, New York, N. Y.

*Andrew Harris, of Harris Bros. & Co., Philadelphia, Pa.

*C. S. Knight, Fort Wayne, Ind.

*E. M. Russell, Agt. Parker Russell Mining and Mfg. Company, St. Louis, Mo.

*H. M. Hubbard, Sec'y, George M. Clarke Gas Stove Company, Chicago, Ill.

ELECTION OF NEW MEMBERS.

On motion of Mr. Littlehales, the Secretary was empowered to cast the ballot of the Association for the election of the gentlemen named as members of the Association. That duty having been performed, the gentlemen were introduced to the Association by the President.

In making the introduction, the President said—I trust the gentlemen who have just been elected to membership will feel that they have as much right in the Association as the oldest member, and will feel it not only their privilege, but their duty, to take a very active part in the proceedings of the meeting.

The Secretary then read the following

REPORT OF COUNCIL.

SAVANNAH, GA., Oct. 15, 1890.

To the Members of the Association:

GENTLEMEN—Your Council would respectfully offer the following report on the work of the Association for the past year:

The Council have approved the following papers to be read during the meeting—

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* Present at this meeting.

"The Mismanagement of Gas Works," by E. G. Cowdery.

"The Extension of the Use of Gas for Purposes Other than Illumination," by E. G. Pratt.

"Gas Coals of the United States," by H. C. Adams.

"The Practical Efficiency of an Illuminating Water Gas Setting," by A. G. Glasgow.

"Inclined Retorts," by Frederic Egner.

"The Gas Engineer and His Pencil," by F. H. Shelton.

"Purification of Gas," by A. E. Forstall.

"Pintsch System," by R. M. Dixon.

"Hints on Electric Lighting by Small Gas Companies," by A. E. Boardman.

The Council have appointed the following gentlemen to serve as the Committee on Nominations, namely:

Thomas Turner, Chairman, Charleston, S. C.; A. B. Slater, Jr., Providence, R. I.; A. W. Littleton, Quincy, Ill.; J. F. Scriver, Montreal, Canada; W. K. Parks, Philadelphia, Pa.

The Council recommend that the Secretary proceed with the publication of volume No. 9 of the proceedings, sending one copy to each member.

The Council recommend that the Secretary be instructed to furnish each of the *Gas Journals* with a copy of the proceedings of this meeting, with the understanding that each paper pays its share of the entire expense of reporting the proceedings.

The Council recommend that as a matter of economy the practice of printing copies of the President's Address be discontinued.

For the same reason the Council recommend that the custom of printing the papers in advance be discontinued.

The Finance Committee have examined the books of the Treasurer as per report attached.

Respectfully submitted,

EMERSON MCMILLIN, *President.*

REPORT OF FINANCE COMMITTEE.

To the Council:

Your Finance Committee have examined the books and

vouchers of the Secretary and Treasurer, C. J. R. Humphreys, for the year ending September 30, 1890, and find the same to be correct.

C. W. Blodget, } Finance
A. E. Boardman, } Committee.

Mr. Littlehales moved the adoption of the report.

The President—There are some recommendations here that it will be well for us to consider. If those who have hitherto favored the printing of the papers in pamphlet form, in advance of the meeting, knew the condition of the treasury, they would hardly object to a discontinuance of the practice. It is almost a matter of necessity; for since we made the large expenditure a year or two ago, for procuring badges for the members of the Association, our treasury has been practically empty. We started a number of little economies, last night at our meeting, and hope that we will, after a while, get back to where we can again take up the publication of the papers in advance. But when we again do that, I hope the publication will be made two or three weeks in advance of the meeting. Finding the papers at the meeting affords no particular advantage to the Association.

The report of Council was adopted.

REPORTS OF SECRETARY AND TREASURER.

The Secretary read the following reports:

Report of the Secretary and Treasurer for year ending September 30, 1890.

Receipts.

Dues for year 1887	$25.00
" " 1888	40.00
" " 1889	170.00
" " 1890	1,010.00
" " 1891	755.00
Initiation fees	360.00
Account of stenographic report of Toronto meeting	96.83

…y of Proceedings, Baltimore meeting……	$24.75	
…lge……	4.00	
…ra copies, Shelton's paper ……	38.00	
	$2,523.58	
…ount brought forward from last year……	199.76	
		$2,723.34

Expenditures.

…penses, Baltimore Meeting……	$254.54	
…ary of Secretary and Treasurer……	600.00	
…nting and Stationery……	439.44	
…mped Envelopes, Stamps, and Sundries……	587.92	
…penses of Reporting Baltimore Meeting……	222.60	
…vertising ……	90 00	
…pense Attending Council Meeting……	75.00	
…penses Savannah Meeting……	35.00	
	$2,304.50	
…nount carried forward to next year……	418.84	
		$2,723.34

…ash in Merchants National Bank of Lawrence……	$402.41
…ash in hand……	16.43
	$418.84
…ue from Members ……	$1,330.00

Honorary Members.

…umber on roll Oct. 1, 1889……	6
…ied during the year……	1
Number on roll Oct. 1, 1890. ……	5

Active Members.

…umber on roll Oct. 1, 1889……	338
…dmitted Oct. 16, 1889 ……	26
	364

Resigned during the year		10
Dropped	" "	6
Died	" "	8
		24
Number on roll Oct. 1, 1890		340
		364

Associate Members.

Number on roll Oct. 1, 1889	5
Admitted Oct. 16, 1889	10
Number on roll Oct. 1, 1890	15

Deceased Members.

Honorary.

Gen. Charles Roome, New York City.

Active.

Cushing, O. E.,	Lowell, Mass.
Douglas, S. H.,	Ann Arbor, Mich.
Forstall, Theobald,	Chicago, Ill.
King, E. J.,	Jacksonville, Ill.
Fullagar, John,	Napa City, Cal.
Houston, Walter B.,	Rahway, N. J.
Parrish, William,	Seneca Falls, N. Y.
Rollins, J. H.,	Worcester, Mass.

On motion of Mr. Greenough, the reports were received and filed.

Mr. A. C. Humphreys, Chairman of Committee of Arrangements, announced that the Committee had decided to make an innovation, in that they had extended to the ladies accompanying members of the Association, and to the ladies of the reception-committee, an invitation to be present at the banquet on Thursday night. (Applause.)

The Secretary read letters of invitation and proffers of courtesies from the Savannah Yacht Club, and the Catholic Library Association, of Savannah. On motion of Mr. Baxter, the invitations were accepted with the thanks of the Association.

ROLL CALL.

The roll call showed the following members were present :

Active Members.

Abel, W. G., - - -	Atlanta, Ga.
Adams, H. C., - - -	Philadelphia, Pa.
Adams, William C., - -	Richmond, Va.
Battin, Isaac, - - -	Omaha, Neb.
Baumgardner, J. H., - -	Lancaster, Pa.
Baxter, Isaac, - - -	Detroit, Mich.
Baxter, W. H., - - -	Petersburg, Va.
Beal, W. R., - - -	New York City.
Benson, F. S., - - -	Brooklyn, N. Y.
Blodget, C. W., - - -	Brooklyn, N. Y.
Boardman, A. E., - -	Macon, Ga.
Boardman, H., - - -	Bangor, Me.
Borgner, C., - - -	Philadelphia, Pa.
Bredel, F., - - - -	New York City.
Bush, J. S., - - -	New York City.
Butterworth, L., - - -	Columbus, O.
Byrne, T. E., - - -	Brooklyn, N. Y.
Cabot, J., - - - -	New York City.
Cartwright, M., - - -	Rochester, N. Y.
Chadwick, H. J., - - -	Lockport, N. Y.
Chambers, J. H., - -	Trenton, N. J.
Chollar, B. E., - - -	Topeka, Kan.
Clark, W., - - -	Philadelphia, Pa.
Coffin, J. A., - - -	Gloucester, Mass.
Coggshall, H. F., - -	Fitchburg, Mass.
Collins, A. P., - - -	New Britain, Conn.
Connelly, T. E., - -	New York City.
Cornell, T. C., - - -	Yonkers, N. Y.
Cosgrove, W. L., - -	Atlanta, Ga.

Cowdery, E. G.	Milwaukee, Wis.
Cowing, J. H.,	Buffalo, N. Y.
Crockett, J. B.,	San Francisco, Cal.
Curley, T.,	Wilmington, Del.
Dell, J.,	St. Louis, Mo.
Diall, M. N.,	Terre Haute, Ind.
Dickey, C. H.,	Baltimore, M. D.
Douglas, D.,	Savannah, Ga.
Egner, F.,	St. Louis, Mo.
Elkins, W. L., Jr.,	Philadelphia, Pa.
Findlay, J. H.,	Ogdensburg, N. Y.
Flemming, D. D.,	Jersey City, N. J.
Floyd, H. E.	New York City.
Fodell, W. P.,	Philadelphia, Pa.
Forbes, J.,	Chattanooga, Tenn.
Forstall, A. E.,	Chicago, Ill.
Foster, T. G.,	Montgomery, Ala.
Fry, C. C.,	Lynn, Mass.
Gardner, J., Jr.	Pittsburg, Pa.
Geggie, D. H.,	Quebec, Can.
Glasgow, A. G.,	Philadelphia, Pa.
Goodwin, W. W.,	Philadelphia, Pa.
Graeff, G. W., Jr.,	Philadelphia, Pa.
Greenough, M. S.,	Boston, Mass.
Griffin, J. J.,	Philadelphia, Pa.
Hambleton, F. H.,	Baltimore, Md.
Hanford, L. C.,	Norwalk, Conn.
Harbison, J. P.,	Hartford, Conn.
Harper, G. H.,	Kansas City, Mo.
Harris, J. A.,	Philadelphia, Pa.
Helme, W. E.,	Philadelphia, Pa.
Hookey, G. S.,	Augusta, Ga.
Humphreys, A. C.,	Philadelphia, Pa.
Humphreys, C. J. R.,	Lawrence, Mass.
Lansden, T. G.,	Washington, D. C.
Leach, H. B.,	Taunton, Mass.
Learned, W. A.,	Newton, Mass.
Littlehales, T.,	Hamilton, Ont.
Littleton, A. W.,	Quincy, Ill.

E.,	Brooklyn, N. Y.
,	Baltimore, Md.
A. J.,	Philadelphia, Pa.
on, J.,	Allegheny, Pa.
l, W.,	Albany, N. Y.
J. H.,	Pittsburgh, Pa.
y, J.,	Philadelphia, Pa.
E.,	Columbus, O.
V. N.,	New York City.
K. M.,	St. Joseph, Mo.
Vm.,	New York City.
W. H.,	Pontiac, Mich.
,	Jersey City, N. J.
.,	Fall River, Mass.
K.,	Philadelphia, Pa.
J.,	Kansas City, Mo.
G.,	Des Moines, Ia.
C. F.,	Lynn, Mass.
S.,	Nashville, Tenn.
K.,	Newport, R. I.
G. G.,	Vincennes, Ind.
V.,	Springfield, Ill.
T.,	Connersville, Ind.
M.,	Jersey City, N. J.
. R.,	St. Louis, Mo.
F.,	Montreal, Can.
. H.,	Philadelphia, Pa.
N.,	Albany, N. Y.
B.,	Providence, R. I.
B., Jr.,	Providence, R. I.
l, J. B.,	Baltimore, Md.
,	Wilkesbarre, Pa.
H.,	Holyoke, Mass.
, J.,	Indianapolis, Ind.
B.,	New Bedford, Mass.
H.,	Warren, O.
. R.,	New York City.
.,	Charleston, S. C.
ol, E.,	Newark, N. J.

Watson, C., - - - -	Camden, N. J.
Weber, O. B., - - -	New York City.
Williams, E. H., - - -	Waterbury, Conn.
Young, J., - - -	Allegheny City, Pa.
Young, P., - - - -	Knoxville, Tenn.

Associate Member.

Barrows, W. E., Phila., Pa.

At this point Vice-President Harbison took the chair, and President McMillin read the following address:

PRESIDENT'S ADDRESS.

Members of American Gas Light Association:

GENTLEMEN—With hearty good will and fellowship I address you to-day, glad to find that, though surrounded with unfamiliar scenes, there are yet many familiar faces here.

We have met for the twofold purpose of profit and pleasure. That we will receive both in full measure is scarcely to be doubted. We will counsel together upon subjects of deep import to our fraternity. In union there is strength; we may, therefore, hope that under the broad light of discussion some truths will stand revealed, and some errors vanish like mist before the sun.

Though these meetings have been held regularly for nearly a score of years, we still find work to do, and willing hands to do it. Old questions, believed to have been intelligently solved in former years, present themselves anew, clothed in another garb, inciting phases of thought probably not dreamed of a decade ago.

With the array of talent that has kindly consented to address us on topics of interest, this must almost of necessity be a profitable meeting. Should it be otherwise, the result will be due to an absence of interest on the part of members, or a lack of ability in the presiding officer to conduct the proceedings in a manner tending to expeditious and connected discussion.

You will have presented to you papers upon the following subjects:

"The Extension of the Use of Gas for Purposes other than Illumination," by E. G. Pratt.

"The Mismanagement of Gas Works," by E. G. Cowdery.

"Gas Coals of the United States," by H. C. Adams.

"The Practical Efficiency of an Illuminating Water Gas Setting," by A. G. Glasgow.

"Inclined Retorts," by Frederic Egner.

"The Gas Engineer and his Pencil," by F. H. Shelton.

"Suggestions of Methods and Systems for Recording the Histories and Accounts of Gas Light Companies," by Wm. P. Fodell.

"Purification of Gas," by A. E. Forstall.

"The Undertaking of Electric Lighting by Small Gas Companies," by A. E. Boardman.

"The Pintsch System," by Robert M. Dixon.

It is to be regretted that the Council failed to obtain a paper upon a subject which, to my mind, will in the near future be one of great interest to our fraternity. I refer to the question of municipal control of lighting. From this direction danger to the lighting industry looms up portentously.

That much may be said in favor of municipal control of lighting cannot be denied by dispassionate and unprejudiced investigators; but that much greater reasons can be urged against it, I verily believe. Nothing can well be said in favor of municipal control of lighting that might not with almost equal force be applied to municipal control of street railways and telephones. The municipality is not a patron of either the street raliway or the telephone to the same extent that it is of lighting companies; but if control is to be assumed upon the ground that the public streets are to be occupied, then the argument must apply with much greater force to railways than to gas companies.

Again, if the idea is to assume municipal control because of the quasi-public character of the business, and for the reason that so great a percentage of the citizens of the municipality are indirectly interested, then the application can be made with greater force to railways than to gas companies.

Writers who have taken the affirmative side of the question

base their argument on the assumption that in a business that must be practically a monopoly, it is best that the municipality conduct it, in order, not that the work will be better done, but that the people may be served at a less cost. Does experience warrant the assumption that monopolists, as the term is applied to lighting companies, charge more for their salable wares than is charged in lines of business where competition, so-called, exists? I think it does not.

That competition exists amongst manufacturers and jobbers, will not be questioned, but that competition in *prices* exists to any marked extent in the sale of goods generally to consumers in cities may be seriously questioned. Grocers of towns and smaller cities have their uniform price for certain brands of flour, coffee, sugar, canned fruits, etc. The retail iron merchants have their card of prices from which they seldom vary, and bakers in almost every city have a uniform price for a definite weight of bread, and the same rule applies to the dealing in most all commodities.

But the Nationalist may say that the absence of monopolistic privileges tends greatly to reduce prices in these lines, and that the public derives benefit in that way. Is this true?

Do retailers of dry goods, boots and shoes, or even the operators in the lines above named, receive a less return on the money invested than do gas, electric or street railway companies? I venture the assertion that double the percentage of profit on investment is made in the very lines of business that are supposed to be in strongest competition. Gas and electric companies of Massachusetts paid 5 per cent. last year, and earned $7\frac{1}{2}$ per cent. on a capital representing less than the actual cash investment.

Again, does experience warrant the assumption that municipalities will, or can, sell to the public at lower prices than do incorporated companies operating under municipal franchises? The preponderance of evidence is very largely against that assumption. One of the ablest and also one of the fairest articles, written upon the affirmative side of this subject, that has come under my notice, is from the pen of a St. Louis citizen, and was published in the November, 1889, number of the *Forum*.

I believe the writer makes no pretentions to any practical

knowledge of the gas industry. But he is a gentleman of keen discernment, a forceful writer, of unquestioned fairness, and a Nationalist from principle. Mistakes that are made are due, I believe, to lack of an intimate knowledge of the business, and not from a desire to misrepresent. In the *Forum* article reference is made to results obtained in the eight gas works in the United States owned by municipalities, and those results are accepted by the author as proof that gas works ought to be controlled by municipalities. Had the writer been an experienced gas manager he probably would have accepted the results as affording positive proof that municipalities should *not* control gas works.

Some of the named works are quite small, and it has not been possible for me to obtain the reports of their superintendents. But reports can be had from two of the largest—Philadelphia and Richmond—and I have accepted the *Forum* figures respecting Wheeling and other smaller places.

Philadelphia has now (and for aught I know) has always had intelligent management. While selling gas at a price much above the prices of some other cities similarly conditioned, it has but recently shown a profit at all commensurate with the magnitude of the business done. During the last fiscal year, after purchasing nearly one-third of its gas from a private corporation at 37 cents per 1,000 feet, it is able to show for the year a profit much smaller than would have been made by a private company manufacturing all its gas. On the gas purchased a saving of more than $200,000 was made. That is, it cost $211,500 less money to purchase from a private company 900,000,000 feet of gas than it would have cost the city to make that quantity. If a private company owned those works it could, and probably would, sell gas at $1.25 per 1,000 feet, and earn more than 6 per cent. on a capital of $25,000,000.

At Philadelphia coal should cost 20 per cent. less than in Boston; a private corporation in the latter city, selling less than half the gas that is sold in Philadelphia, charges from $1 to $1.30 per 1,000 feet, the average being about $1.25, or nearly 20 per cent. less than the price charged in Philadelphia ($1.50), yet the Boston company paid 10 per cent. dividends on the par value of its capital stock last year. It is fair, however, to state

that the capital stock does not correctly represent all of the money invested. The total quantity of gas sold in the State of Massachusetts last year, in villages, towns and cities, was sold at an average price that was less than gas is sold for in Philadelphia, and this, too, notwithstanding the greatly increased cost of coal in Massachusetts, and the additional disadvantage that the total of 75 different companies sold but little more gas than was sold in Philadelphia by the municipality. Apologists for the condition of affairs existing in the Quaker City say that it is an exceptional case, and that other departments of public service there are also managed extravagantly. I neither admit the implied charge, nor do I see the force of that argument.

But let us turn to Richmond, Va., where conditions are believed to be at least normal, and the management also intelligent. Richmond sells gas at a price ($1.50) 50 per cent. above that charged in another capital city located but little farther from gas coal fields. Giving Richmond the benefit of $1 per 1,000 feet for gas now *actually* furnished free for city use, the profits in the business are then less than the profits to stockholders of the company with which I have compared it, notwithstanding the fact noted above that Richmond taxes its patrons 50 per cent. more for its gas than does the private company.

Wheeling may fairly be taken as a case in point which demonstrates the advantage of municipal control. There gas is sold at 75 cents per 1,000 feet. Yet even that will not be a striking instance, when the conditions are analyzed.

Coal at Wheeling costs (less amount received for residuals) but 4.5 cents per 1,000 feet of gas; it will, therefore, be readily seen that there are other works in the country controlled by private companies who sell their gas at as low figures as does Wheeling, *plus* additional cost of coal. In the article referred to it is asserted that did the Wheeling works belong to a private company gas would now be selling at $1.50. The best reply to this is to note the fact that the Pittsburgh Gas Company, similarly located, sold gas at $1 per 1,000 feet, long before Wheeling did, and that another capital city of about the same population as Richmond, making about the same quantity of gas, and located 250 miles from the gas coal field, sells gas for $1.

If it is a fact that the municipal governments generally secure

intelligent management for their gas works, then why is it that the net results are not as good as those of private companies? There are two or three reasons for this, all, however, being based in a greater or less degree on the fact that the municipal works are under political domination. The *Forum* article lays great stress (and properly too, though important items of expense were omitted) on the figures given by our deceased Past-President, Theo. Forstall, in his annual address in 1883; yet in that address Mr. Forstall put the cost of labor for gas in holder at 15 cents per 1,000 feet, while the cost, as nearly as may be ascertained, is at Philadelphia, 31 cents; Richmond, 50 cents; Danville, 45.8 cents; Alexandria, 34.5 cents; Charlottesville, 34 cents; Wheeling, 26 cents; Bellefontaine, 32.8 cents; Henderson, 23.8 cents. For the total gas made, the cost of wages is more than 100 per cent. above the estimated figure of cost made by the gentleman on whose statements are based many of the conclusions in the *Forum* article.

Probably in no other one item would the baneful influence of politics be so strikingly exemplified as in that of labor. Notwithstanding the present high cost of labor at the works of one of the municipalities named, the item appears to be low under the present regime, compared with that of former years. I quote from the very interesting report of the chief officer. He says, speaking of the condition in the Spring of 1887: "The men numbered 2,257, and the cost of skilled and unskilled labor, especially the latter, was startling. The manufacturing capacity was insufficient to meet the demand at the period of greatest consumption, and the pipes and mains were totally inadequate to distribute the gas made. In fact the works were short of everything but men."

Workmen are voters, and in municipal works they are often more than that, they are political workers, and must be taken care of, and the gas works managers are impotent to control the size of the pay roll, and did they attempt it, doubtless their employment by the city would soon be a thing of the past.

It is asserted that while 90 per cent. of the water works of the country are under municipal control, there is not an instance on record of political corruption. The assertion is not based on fact, but if it were, gas interests in general, *under private*

management, may readily submit to a comparison with water works under *municipal control*. The average price charged for gas now in the United States is not 50 per cent. of the price charged 20 years ago, while it is safe to say there has been practically no reduction in the average price charged for water during the same period. The customary charge for water in residences is 20 cents per 1,000 gallons; 20 cents multiplied by 7.5 gallons equals $1.50 per 1,000 feet, or actually a higher price than is charged in most large cities for gas.

Much is made of the fact that with lighting companies under municipal control, the street lighting practically costs nothing.

A more unfair practice than the one that makes the assertion virtually true, would be hard to conceive. The private patrons of the works, generally much less than half of the population, are by this practice made to pay not only their own gas bills, but also the entire cost of street lighting and the lighting of public buildings.

The prediction is now made that the policy inaugurated by Philadelphia, that of buying gas from manufacturing stations and distributing through municipal mains, *will become contagious*. It will be advocated by Nationalists and communists generally. In this way duplication of mains will be avoided, while competition may be had in manufacture. What a harvest this will furnish for the patentees of "cheap processes!"

That communities are occasionally imposed upon by lighting companies cannot be truthfully denied. That gas companies are often put to enormous expense to maintain their rights is a fact familiar to us all. What plan can be suggested tending to fairer dealing in the future? There are three plans or modes of protection that suggest themselves. First: That of having a State gas commission, as in Massachusetts. The trial of that plan has proven eminently successful. Second: Statutory control, with provisions limiting dividends, but allowing increased dividends on reduction of price, thus giving the public an opportunity to profit by new and improved processes. This is practically the plan practiced in England, and which practice has contributed largely to give gas to the English public at about half the price paid elsewhere. This has not tended to benefit electric companies. Third: The Ohio plan which gives

to city councils the right to fix the price of gas. The Supreme Court of Ohio has in two instances decided that law to be constitutional; but it has also said that the price fixed shall be a reasonable one. The United States Courts have decided in similar cases that prices thus established shall not only be reasonable, but that the question of reasonableness must be judicially ascertained.

The Ohio plan is weak in this, that it does not specifically guarantee freedom from the raids of so-called competitive companies. But while the law is thus defective by omission in its wording, the practical effect has been to virtually exclude would-be competitive companies from Ohio cities. It may be safely asserted that any plan adopted for the benefit of the people which does not prohibit the duplication of gas mains must ultimately fail of its object.

A few years ago there were strifes existing between various systems of gas making; coal gas men were solidly arrayed against water gas advocates. To-day there are few large cities in the country but what are supplied, at least in part, with water gas. Indeed, it may well be an open question whether the annual production of coal gas in the United States is now as large as the production of water gas.

There are no longer men who pride themselves that they are —under any and all circumstances—strictly coal gas, or strictly water gas engineers. They are gas engineers. Possibly a few years hence they will be *light* engineers. The world moves and the members of our Association do not lag behind.

While there may be companies making water gas that might with advantage to their stockholders have continued to make coal gas, yet, on the whole, it will be admitted that if no water gas was made in this country at the present time, we would all be deriving 5 to 10 cents less on the 1,000 feet of gas made for our residuals than we are now obtaining. Angels are sometimes entertained unawares even in modern times.

There is one branch of the gas industry that does not seem to be making rapid progress, the much abused and much praised fuel gas. The question as to whether it is to become a factor of importance in our business is apparently almost as far from being solved to-day, as when we met a year ago. A few more

daring spirits have tried and are trying it. The latest trumpet blast comes from Boston. Jackson, Mich., continues to make it, and practically the same parties, I believe, have recently commenced operations at Hyde Park, Chicago. The effort at Akron, O., is reported to have prospects of final success. Possibly many other places have tried and are trying it on a small scale. Not much encouragement can be drawn from these scattering attempts after the promises of success that have been heralded broadcast for three or four years.

On the other hand, I know of no occurrence that should be regarded as especially discouraging. On the whole, we may conclude that some advance has been made; quite as much, perhaps, as was made during the first three years in the history of water gas making, or during a similar period in the history of incandescent electric lighting.

Theoretically, it can be clearly shown that fuel gas cannot be made by any known process so cheaply as to be able to compete with coal for domestic use. But this does not signify much, after all. There are cities in the country where soft coal can be had for \$1.50 to \$2 per ton; and yet, in these same cities, many thousands of tons of anthracite coal are annually sold at \$6.50 to \$8 per ton. Why? Because it is a cleanly fuel. Will not the same rule hold good as to gas fuel?

But the water gas advocate says producer gas will not do for fuel. It is too heavy to transport, and it is very low in heat units, and the flame is so easily extinguished as to make the gas dangerous to use. The producer gas man's reply should be, "Well, water gas man, go on and sell your non-illuminating fuel water gas, if you want to; I will not disturb you, nor try to compel you to use even a mixture of producer gas."

The coal gas advocate not only endorses all that the water gas man says about producer gas, but he will exhibit an array of figures, that to his mind, should convince any sane man that fuel water gas, owing to *its* low calorific value, must, of necessity, be very much dearer for the poor consumer to use than would be plain 17 candle coal gas. Of course he does not forget to bring out all the expert testimony showing the absolutely poisonous properties of water gas.

Both the producer gas and water gas advocates will tell the

coal gas man that while his product is all right, his prices must be such that after the consumer has paid for warming his premises with coal gas during the month of December, the said consumer would be glad to inhale a little carbon monoxide as an anæsthetic; that indeed the dose would need to be quite large to restore the nervous system to its normal placidity.

Now, if each and every one of us would devote more of our time and energy to reducing to a commercial commodity our own ideas, and less of our time trying to convince the world that our confreres are wrong, I believe that when we assemble a year hence the doubt that now hedges about the fuel gas question will have been dispelled, and it will be pronounced a failure, or admitted to possess the elements of future success.

Unless *all* be failures, some one of the processes or systems will be better than the others. Both fame and fortune will reward the successful inventor, therefore it is not wise to waste our time trying to convince others that they are on the wrong road. Let them alone! Their mistakes tend to increase our chances of success.

The twin industry, electric lighting, has, during the last year, been making strides unparalleled. Its progress since the first light was commercially used is almost beyond conception. Like water gas, this industry was first received by the members of our Association as a subtle enemy of the gas business. Now it is said that more than 300 gas companies employ it—some with the result of increasing their dividends, while others are apparently using it as an agency for disbursing surplus.

An authority asserted a year ago that there were then 300,000 arc and 3,000,000 incandescent lights in the United States. There must be many more now. When we remember that 20 years ago there was not an electric light commercially used in all the world, we may well be amazed at the progress made.

I need not tell you that *not all* of this wonderful success has been due to the real merits of electric lighting. Part is due to merit, part to the charm that attaches itself to anything new, but a greater part to intelligent promotion, energetic and scientific management, and to astonishing liberality. Officers of many gas companies might with profit sit at the feet of some electric managers and gather crumbs of wisdom.

Possibly in the not far distant future your Council will recommend to the Association an amendment to the constitution. The amendment will strike out the word "Gas" in the name of the Association, or suggest the alternative proposition to add the words, "and electric."

How to popularize gas lighting, is as live a question to-day as it was 10 years ago. Consumers continue to discredit the meter, and too often also the meter reader, and not seldom the whole office force. It is not uncommon to hear a man say that while electric lights may cost him more than gas, he has the satisfaction of knowing beforehand just what he has to pay for his light, while with gas, he says, it is always the unexpected that is happening. Errors in reading do sometimes occur, yet, we all know that, taken one month with another, the consumer pays only for the gas that is consumed on his premises. But he feels that he is at the mercy of the gas company, and, knowing the weakness of human nature, he concludes that he is occasionally taxed for more gas than he has used.

As gas company officers and clerks cannot ever hope to entirely disabuse the average consumer's mind of his erroneous ideas respecting the measurement of gas, it behooves us to try in other ways to please our patrons. Too often sufficient personal attention is not accorded a consumer. I have many times seen a consumer approach the pay window of a gas company's counter to pay a bill, wait there for two or three minutes, and, receiving no attention, move to another window, only to wait two or three minutes more. By this time he begins to feel provoked, and perhaps concludes to go to his office and let the gas company collector come there for his money, possibly saying to himself, "If I cannot be waited on when I have taken the trouble to come to the gas office, they will have to do as I have to do with my accounts—send after them."

Of course instances of this character occur only when clerks are busily engaged at other work, but no other work should ever stand in the way of giving a customer immediate attention, even though his visit may be to find fault instead of to pay a bill.

It is not an uncommon sight in the offices of large gas companies to see consumers formed in a line in order to secure

their turn at the pay window, and this, too, when perhaps there are several other pay windows with no clerks in attendance. It is unwise to permit this. One may good naturedly get into line with a dozen others before him, if he is after a ticket to the opera; he then does it of choice, and for his contemplated pleasure. But in a gas office he will feel that he is being inconvenienced, and possibly humiliated, wholly for the gas company's benefit.

Some large companies have introduced the practice of having a number of sub-offices or pay stations scattered throughout the city, these offices being controlled by some express company. The practice is popular with consumers.

In cities of 100,000 to 500,000 inhabitants there may well be 10 to 40 pay stations. The gas bills are delivered by mail or by hand to the consumer's residence or office. Before the expiration of the discount period—if one is allowed—the consumer steps to the nearest pay station, generally a drug store, and pays the gas bill. He has saved one or two street car fares and perhaps an hour's time; he has attended to the matter at his leisure, generally after usual business hours. For this convenience he pays the agent 5 cents on bills of $5 and under, and 8 cents on bills over $5. The next day the agent turns over the gas collections and half the commission to the express company. For *his* trouble he retains one-half the commission and probably makes a sale to the gas consumer before he leaves the store. The express company receives as compensation for its trouble and responsibility half the commission, and largely increases its express business proper by having these convenient stations for receiving parcel packages.

While it is both right and politic to do all we can consistently to keep our patrons satisfied, it is also important, not only from a financial standpoint, but from a humanitarian view, that we endeavor to render pleasant the condition of our employés, especially those engaged in and about the generating plant. The life of a gas maker is a dreary one at best, and a little attention on the part of the company to his personal comforts will generally be appreciated. Reading rooms, card rooms, bath rooms, a hall in which to hold meetings, and

where the younger element may occasionally enjoy an evening dance, may be safely considered a good investment. Try it.

Raiders are still abroad in the land. The men with processes that can make gas for almost nothing, and still have a valuable residual, do not seem to despair in their efforts to get a standing in cities already well supplied. If they were only modest enough to go to small towns not now supplied with gas, and demonstrate the value of the process there, they would merit the everlasting gratitude of existing companies. Until statutes of the several States have made raiding impossible, the consumer will not be able to purchase gas at the possible minimum price.

In Association matters, I am pleased to report a continued growth in membership. The active members now number 340; the associate members 15; honorary members 5; total membership 360.

While the membership is increasing satisfactorily, the unpaid dues are also increasing to an alarming extent. Personally, I had supposed that members failed to pay simply through neglect or forgetfulness; but the Secretary informs me that 90 per cent. of sight drafts made on members (who had previous notice that the drafts would be made) were returned unpaid. The dues are certainly not so large as to be burdensome, and yet in the aggregate the unpaid dues make a total sum that is indispensable to the Association. May we not hope that members will give heed to this appeal, and promptly remit to the Secretary?

The American Association for nearly a score of years has been almost annually the recipient of hospitality at the hands of gas companies, and from our friends engaged in business kindred to that of our own. In nearly all the large cities in the country we have been royally entertained; several of the cities have so contributed to our enjoyment on two or more occasions. It has doubtless been a pleasure to the donors to thus contribute, and the courtesies have been greatly appreciated by the attending members. But may I not ask, without being misunderstood, if the time has not almost arrived when the tender of a banquet may be declined with propriety, and without giving offense?

I earnestly suggest that action be taken at this meeting, looking to the abandonment of free banquets, and that the rule of having each member pay for his seat at the banquet board be inaugurated at our next meeting, the Association paying only for invited guests.

The question of when the term of newly elected officers of the Association shall begin and when terminate, is one that at some future date may be of importance, and I respectfully suggest that the question should be finally determined during this meeting.

The constitution provides that officers shall be elected annually, and that they shall assume office immediately after the meeting at which they have been elected. That is not quite clear. What constitutes the meeting referred to? The constitution says that the annual meeting shall be held on the third Wednesday of October. It does not provide for a three days' session, but no one would question the right of the Association to continue the meeting by adjournment from day to day; and if this is admitted, then it has the same right to adjourn from week to week and month to month. If this be true, and the *meeting* continues until an adjournment without day is taken, the officers-elect might be kept out of office until the next annual meeting. Of course, such a proceeding is not likely to occur. The question can be definitely settled by the Association adopting a resolution in substance as follows:

"*Resolved*, That it is the sense of the Association that under the provisions of the constitution the officers elect should enter upon the discharge of their respective duties on the Saturday succeeding the third Wednesday in October of each year."

It has been the practice to have the old officers hold over during the three days of assembly. This seems proper enough, but if a *sine die* adjournment is had on the evening of the second day, then for the officers to hold over on the third day would seem to be an infraction of the constitutional rule, a rule in this instance more honored in the breach than in the observance.

There is room, however, to question the propriety of the old

officers holding their positions *after adjournment on the day that formal announcement has been made of the result of annual election.*

But whether or not this construction of the constitution is a fair one, it is quite clear that the Association may by resolution declare that construction to be the intent of the wording of the constitution and the desire of the Association. I, therefore, suggest to you that a little spice might be added to our proceeding by making this the practice. The officers are elected on the first day. The president-elect can prepare a short address during the evening and assume the chair on the following morning. This gives him an opportunity to deliver his inaugural at the beginning, instead of, as by the anomalous practice now in vogue, delivering an inaugural at the close of his term. Of course, this same officer would submit a message at the succeeding annual meeting.

Should this view of the question meet your approbation I suggest that the following preamble and resolution be adopted:

"*Whereas*, The constitution provides that the annual meeting of the Association at which officers are to be elected shall be held on the third Wednesday of October of each year; *and whereas*, The constitution also provides that the officers-elect shall assume office immediately after the meeting at which they have been elected, now, therefore, be it

"*Resolved*, That it is the sense of the Association that the election of officers shall occur on the third Wednesday in October of each year, and that the officers-elect shall assume office the morning of the day succeeding their election."

I feel I may with propriety recommend this change in our practice as it tends to curtail my term of office if it is adopted.

We may expect at this meeting a preliminary report from the Committee on the World's Fair. In this connection I respectfully submit to your consideration whether—not only our Council, but also our sister Associations, may not have erred, if I may be pardoned the word, in the composition of their committees.

I believe all the Associations, except the Ohio, have associate members, and I fear that class has not received adequate recognition on the committee. If a mistake has been made, we all

know it is the result of oversight, and not intentional. It is doubtful if 20 persons eligible under our present constitution for active membership, will make any sort of an exhibit at the great exposition. Is it not eminently proper, then, that the class of membership that is expected to make the display should in a very large measure dominate the committee of arrangements? I suggest that at least a large representation on the committee should be offered to associate members, and to active members who are engaged in manufacturing gas apparatus.

I feel it a duty incumbent, though by no means a pleasant one, to warn the Association that there is possible danger ahead, and that it will require caution and nerve to prevent us making a debt in connection with the World's Fair exhibit that may embarrass the Association for years to come. As the Committee is now constituted, we all know that no money will be expended injudiciously, but if the Association should order that no debts be incurred for which the Council has not made an appropriation, and that the Council be instructed to make no appropriation for which the money is not at the time in the Treasury, it would be an additional safeguard, and could do no possible harm.

Never before in the history of the Association has death made such inroads in the list of our membership. Nor have we ever before in any year had to chronicle the death of so many who were eminent in our profession. In the order of demise:

Edward J. King, died October 28th, 1889; Oliver E. Cushing, January 17th, 1890; Theobald Forstall, January 19th, 1890; William Parrish, January 19th, 1890; Walter B. Houston, April 3d, 1890; James Henri Rollins, June 19th, 1890; General Charles Roome, June 28th, 1890.

In our living membership could seven names be selected of persons who, taken all in all, have done more to influence the views and mould the character of the American gas engineer of to-day, than did the departed friends whose names constitute this sad list? Past-Presidents of the American Association, Past-Presidents of sister Associations, men eminent for

their engineering talent, for their scientific acumen, some of them distinguished for their long years of faithful and successful service. All honored for their personal worth, their integrity and high sense of honor, and for their social amenities. They are gone, but their example remains. To their friends they are dead, but to the profession the influence of their lives is yet a living reality.

To the members who have kindly prepared papers to be read at this meeting, I tender my sincere thanks.

For the distinguished honor of having been called to preside over the affairs of the Association I feel deeply grateful.

Committee on President's Address.

The Chairman—Gentlemen of the Association, you will agree with me, we have been permitted to listen to words of wisdom as written out in the address of our President. What is your pleasure with regard to this address?

On motion of Mr. Cowdery, the address was referred by the Chairman to a committee of seven for consideration and report. The gentlemen named on the Committee were Messrs. E. G. Cowdery, Oscar Weber, A. G. Glasgow, Isaac Baxter, D. H. Geggie, W. H. Baxter and G. S. Hookey.

Welcoming Commissioner Barker.

The President—I see that the Association has this morning the honor of the presence of a member of the Massachusetts State Gas Commission. In your behalf I would invite Mr. Barker to come forward and give us the honor of his presence on the platform. Gentlemen of the Association, I take pleasure in introducing to you Mr. Barker, of the Massachusetts Gas Commission, whom many of you, and indeed all of us, already know.

Mr. Barker—*Mr. Chairman and Members of the Association:* I did not understand that this was a part of the programme. I supposed I might be permitted, like the Past-Presidents of the Association possibly, to take a seat upon the platform, and not be asked to take up your time with anything like an address. I may, however, thank the Chairman for the courteous

words of invitation he has been pleased to tender to me in my official capacity. I am especially grateful for the very cordial invitation which I had previously received to attend this meeting of the Association. The Board is under great obligations to the members of this Association for the very kind and cordial assistance which it has been tendered in the past; and the very pleasant welcome which I have already received from the members of this Association (from many of them individually) at this reunion, indicates that they are still to continue to assist us in our work, and to thereby be of very substantial benefit to the various companies within our jurisdiction. I am aware, Mr. Chairman, that there is a very interesting, and quite a large amount of business to be transacted; I am interested in it myself; I know that the Association is here for business purposes; and the very large attendance which is here forbids absolutely that I should occupy any more of your time. I thank you very cordially for your courtesy, and for your pleasant words. (Applause.)

Report of Committee on Nominations.

The President—Is the Committee on Nominations ready to report? If so, the Secretary will read the report of the committee.

The Secretary read the following report:

The Committee on Nominations beg to report that they recommend the following gentlemen as officers for the ensuing year:

President—John P. Harbison, Hartford, Conn.

Vice-Presidents—Wm. H. White, New York; A. E. Boardman, Macon, Ga.; W. H. Pearson, Toronto, Canada.

Secretary and Treasurer—C. J. R. Humphreys, Lawrence, Mass.

Members of Council—(Term expires 1892)—Charles H. Nettleton, Birmingham, Conn.; James Somerville, Indianapolis, Ind.; A. W. Littleton, Quincy, Ill.; Frederic Egner, St. Louis, Mo.

For the Committee,
Thomas Turner, *Chairman.*

ELECTION OF OFFICERS.

On motion of Mr. Littlehales, the report was adopted, and the Secretary was instructed to cast the ballot of the Association in favor of the election of the nominees. Having reported to that effect, the following introductions and responses ensued :

THE PRESIDENT—Gentlemen, you have elected to preside over the meetings of the Association for the coming year (and, I hope, commencing to-morrow morning at 10 o'clock) my esteemed friend, Mr. Harbison, who will please come to the platform. It affords me a great deal of pleasure to introduce to you, Mr. Harbison, of Connecticut, and a sample of the noble yeomanry of New England. Many of you have not before seen him, but all have heard of him. I hope you will lend him the same assistance in his work for the coming year as you have to the present incumbent of the chair. (Applause.)

MR. HARBISON—Mr President, gentlemen, brothers of the American Gas Light Association :—I feel deeply grateful for the honor conferred upon me, as I should. To be chosen the presiding officer of the American Gas Light Association is an honor to which any member ought to aspire. I know of no greater honor that can be put upon a man in our profession, in any part of the country, than to be called to preside over the deliberations of such a body of men as is before me. As I review the past, and remember who have occupied this honorable position, I feel the responsibilities which devolve upon me; and I accept the honor conferred with fear and trembling, knowing with what honor, grace, dignity and efficiency, the President's chair has been and is now filled. I shall rely upon the cordial co-operation, hearty sympathy, efficient and active service of every member, active, associate and honorary, of this Association, for the success of our gathering during the year to which we are looking forward; and I hope, as I shall earnestly strive, that when it shall be my pleasure and privilege to introduce my successor, I may have in some small degree, come up to your expectations in the conduct of the business of the year to which we are looking forward. Again, gentlemen, I thank you for the honor. (Applause.)

The President—You have elected for your Vice-Presidents William Henry White, of New York, A. E. Boardman, of Macon, and William H. Pearson, of Toronto. Captain White is not here, and I believe that Mr. Pearson is not here. Therefore Mr. Boardman will speak for the other two as well as for himself.

Mr. Boardman—It is a very unexpected pleasure that I have of addressing you in behalf of my brother officers as well as of myself. It is not often that I get a chance to say anything, and for that reason I am more than grateful to the President for giving me this chance. You also will probably be very grateful that my remarks will be very brief. Having two associates in the Vice-President's chair, I will give you the thanks of those gentlemen for the honor you have conferred upon them; and I hope, when, in their turn, it is necessary for them to conduct the business of the meetings, they will be able to do it as gracefully as those who have and are presiding over them. Again I thank you for myself and for them.

The President—For members of your Council you have elected Mr. C. H. Nettleton, who is unfortunately absent, Mr. James Somerville, Mr. A. W. Littleton (the honored Secretary of the Western Association), and Mr. Frederic Egner.

Mr. Somerville—Gentlemen, I thank you very much for electing me to this honorable position. I will try to do my duty.

Mr. Egner—Mr. President and gentlemen, I thank you for the honor conferred. I cannot say very much, because everything has been said by my predecessors, and I hope, therefore, you will excuse me. I trust, also, that I will do my duty, as Mr. Somerville has promised. I will try to, anyway.

Reading the Papers.

Current routine business having been disposed of, the President introduced Mr. E. G. Cowdery, of Milwaukee, Wis., who read a paper entitled—

THE MISMANAGEMENT OF GAS WORKS.

There has recently been expressed some difference of opinion as to the cause of the wonderful success achieved within the past few years among gas companies. Formerly it was thought impossible to make gas as cheaply as it is now sold. Such advancement has been made, however, within a comparatively short time, and right in the face of the advancement of electricity as a lighting agent, and right at a time when the outside public expected to see us lose ground, if not become extinct altogether. Why is this so? How has it been accomplished? This question has caused many to consider; and while some have given the credit of accomplishing such a result to good, sound, business management, others have considered that our companies, if not our works, were not yet conducted upon such a basis. It would not be consistent in me to assert which of the above interpretations is right. Individually, I do not believe the cause can be attributed wholly to good management. It has been very largely brought about by the condition of the times—fortunate conditions, which have given the business a lift in spite of itself. No doubt the advancement has been helped by business methods, which if not altogether good, have shown such a marked improvement over those immediately preceding that they have seemed to many remarkably good. At the same time there is no doubt but that the business and progress in it is, and has been, greatly retarded by methods which are not sound in principle, but greatly speculative in their nature.

In the management of our works great improvements have been achieved within the past few years, and at the present day, while there are very many things practiced by managers which are far from right, yet, among the majority, I believe, the management is good. Whether or not this summary of the situation is correct, the argument of the question will call for a very complete analysis. My present effort will be devoted, not to making any positive argument upon either side of this question, but simply to open the subject by bringing to your notice such points of mismanagement as have come to my notice. It is to be hoped that this Association will feel such interest in this sub-

ject that it will take it up with the earnestness that has characterized it with other subjects which always developed a great deal of good.

I do not mean to convey to you at the outset, that our methods are all wrong at present; but that the combined thought and efforts of this Association cannot help but cause a decided improvement in any line to which it devotes its attention. To criticise the management, as carried out in different places, will lead to our selecting the best points developed, and, certainly, to bettering our methods. It is quite difficult to make a distinction between conducting the affairs of a gas company and those of a gas works, as they are ordinarily carried out. With a great many companies, and, I venture to say, with a majority, it would be hard to locate the responsibility for any mistakes; for such a responsibility is assumed in part by so many different officers, and not at all by any of them. To accomplish anything there is but one right way. To manage the affairs of any corporation there is but one right way, and that is to have a head to it. Such head I assume to be the manager, and such manager would of course, manage all the affairs of the corporation. With a gas company it is particularly so. Somebody must assume responsibilities which interweave themselves one within the other in such a manner that if divided between two or more parties, they can find so many opportunities to operate one against the other and shirk the responsibility that it would be difficult to obtain the best results. If the management place one man at the head of the works, another at the head of the street department, another at the head of the meter department, all without a practical man over them, each supreme in his own department, then who assumes the responsibility for leakage? Who assumes the responsibility of satisfying the consumer? Who is responsible for the financial success of the company? It is within the power of any one of the above departments to be very detrimental to the success of the company, and in such a way that it would be difficult to fix the responsibility.

It seems the proper way to overcome this difficulty and give the best management, to have at the head of the company a practical man acting as manager, and to have such manager capable of assuming all responsibility. It may seem to some of

you that the above comes rather more under the head of the management of gas companies; but it is introduced into this article to show that the manager of a works having exclusively the works to look after, cannot do justice to himself or the company.

Again, the fixing, shaping, and following of the policy of management is one of the very important points needing our attention. It involves, of course, the policy of the company; but it must also involve the policy to be carried out in the works. If such policy be a proper one, it will be that the public shall be served as the merchant serves his customer when seeking to make a name and a business, while engaged in excessive competition. That is, they shall be served with the best possible article at the least possible cost. A gas company should follow this same principle, only making such profits as will return them a dividend on their capital such as the times will admit of or demand.

I do not mean, of course, that they shall do else than to lay aside a sufficient amount of surplus to cover depreciation.

A company should have everything that is right and fair for them to have; but everything in excess of this is due to the public to have the benefit of.

A semi-public corporation, such as a gas company, owe this much to the public, and when they honestly serve them under such a policy, they may look for public appreciation. In these days of corruption they would be as sure to get it as the night is to come, and would be assured of a long and profitable life with a fair return upon their money always. How much better would such an investment be than one returning immense profits one year and little or none for several years following.

It has been mentioned above that the true policy is to furnish the best possible article. It is but recently that managers have come to realize that because a 16-candle power gas was considered good at one time, it could not always be so considered. It is quite true that among gas engineers there lurks a tendency to stick to existing and well known methods. It may not be more so than among others in other lines of business, but it is noticeable in our line. While the man should not be too enthusiastic over any new idea which his conservative judgment considers to

be of merit he should give such new idea due consideration. If the public pronounce the incandescent electric light superior to gas light, what is the use of devoting our every effort to arguing them out of it; better devote our efforts to making the gas light of such quality that they cannot help but see the difference.

Within the past 15 years, gas companies have realized the necessity of reducing the cost of light to the consumer; they have, consequently, realized the necessity of studying economy, and have kept up a continual warfare against careless and extravagant methods until they have accomplished wonders.

The cost is now where they can afford to, and the times demand that they shall, supply a better light.

Let them now apply their energies in this direction.

The best managed companies to-day are those that supply their works with such apparatus as will produce the very best and strongest light. The days of 16-candle power gas are rapidly going by, and he that quickest makes up his mind to this will profit most by so doing.

We shall find plenty of opportunities to criticize the management of the works more directly as we enter the works.

What kind of management would you call it where the responsible officer cannot tell you the cost of his gas in detail? Where, because some item costs more than his neighbor, he cannot tell you why? What kind of management is it that keeps no record of all this detail? What kind of management is it that has no system to work under, but works from hand to mouth as each day's necessities are presented? What kind of management is it that will stick to old methods and customs and appliances until every one else has discarded them, for fear the newer would not be so greatly a decided success, when, by a little investigation and the exercise of a little judgment, it should know the new was superior to the old! There is no question of how you will answer the above queries. You all know these methods are the foundation of mismanagement; it is not necessary to dwell upon it. The best management will look after every detail in the works, will know its cost each month, and will know and carry out the possibility to do better. It is not necessary that the best management will always make

the best gas the cheapest, but that it shall make the most of the advantages in its particular locality.

The cost of material, the value of residuals, the wages that labor demands, is different in different places, all the circumstances are different, perhaps, and it would be extremely unfair to judge of the management by the cost of the product.

The cost is also greatly influenced by the arrangement and location of the works. Above all, to obtain the best results, to make good management show its best in the returns, the works should be properly built and arranged.

The mistake of adding here and there, of modifying portions of old works, etc., has been, and is to-day, frequently made. Many times a comparatively small amount of additional money would have allowed one to make the improvements of a more permanent character; but the necessity of satisfying directors by the very smallest expenditure has prevented. It is a great mistake in management to let a small amount of additional capital stand in the way of completing a works and putting it in shape to produce the best known results. In such arranging and building, one should provide for every probable emergency. Too often, again, is the desire shown to save in the first cost by omitting necessary portions of apparatus.

To call your attention to a works supplying a city of 8,000 to 10,000 people absolutely with no other means of producing gas than a single water gas cupola, will seem to you absurd on the part of any management; but such a works is in operation, and doubtless there are many equally absurd methods practiced in other places. In many cases the management may mean well enough, but such unwarranted risks should never be carried for a single day. To rank with the well managed the works should be kept in good repair.

It is significant of poor management when the works is let run down through a desire to devote every cent to make a showing upon the yearly returns. The only reasonable excuse the management can make for such an action is that they really cannot afford it. In a season of sunshine prepare for a storm; so in seasons of prosperity in business, make preparations for the fruitless years.

We cannot do this better than by keeping our works in good

repair; then, when misfortune overtakes us and it is necessary, we can discontinue our repairs for a year or two without seriously menacing the condition of our works.

Another mistake very common at the present day is the tendency among managers to force gas upon the consumers by excessive pressure.

Managers are ambitious to keep up their increase in consumption, not only because it is a nice thing to talk about, but it helps in reducing the cost of each 1,000 feet made.

As electricity has a tendency in some cases to take away the gas consumer, and, again, the reduction in the selling price has a tendency to reduce the income, the manager cannot wholly restrain his inclination to make the public shoulder the loss.

Such a proceeding is wholly unwarranted and should never be practiced; rather make the consumer's bill as light as practicable, than to force him to consume a large amount.

If we are looking for all the errors of management, we must find those that are introducing an excess of air into the composition of gas. We all believe the least possible portion of air is an injury. We know that an amount exceeding 1 per cent. is very injurious and quickly noticeable.

Any excess of air stratifies in the holder and settles to the bottom, if the holder is at rest and undisturbed for two or three hours.

When gas is turned on the street, from such holder, the effect is a dull, red, heavy-looking light, with very little luminosity. After a half hour or an hour, according to the quantity of air, this effect is lost and the gas appears all right. The general effect upon the public is even worse than an evenly poor gas, as it gives them the comparison and forces it to their notice. As stated before, we all believe this an injury, but, as is the case with most of us, the use of oxide purifiers requires the introduction of such air.

The mistake is made in carelessness in introducing it. The only safe and satisfactory way is to draw no vacuum with your exhauster, and thus preclude the possibility of introducing it in such a manner, but to inject the air back of the exhauster by means of a steam injector, or otherwise, always measuring the amount of air by drawing it through a meter. In no case let

this amount of air be estimated, and in no case let it exceed 1 per cent. If your oxide purifiers do not act properly under this amount, get better oxide. Analyze your gas frequently for nitrogen, and if the amount of nitrogen exceeds 5 per cent., you may be sure you are introducing a surplus of air somewhere.

Many, I believe, either do not or will not believe their gas contains an excess of air; but an analysis would easily prove it to them. It is possible that the present management might be improved by giving the disposal of residuals more attention. In our Association this subject has been discussed, at length, at different times, with the result, no doubt, of increasing our energies and bettering results in this direction. We know these residuals are valuable, and we know that it is possible to greatly increase our income from this source, if we could only find the proper way to do it. Our ammonia, in many cases, is disposed of at one-half what ought to be obtained for it. Coal tar has not, in years, brought anything like what it ought, until lately. In the West some companies are receiving $5 per barrel, and in Chicago it is retailing for $8. These prices are no doubt good, but perhaps not more than it is worth. Our spent oxide has to be thrown away, and, in many cases, we have to pay some one to take it away, when it ought to sell for enough to pay for its first cost, or even more.

To remedy this why should we wait for someone to invest his money to help us out? Why not follow the now well-established custom of combinations and trusts, and put all our residuals in one pot?

Have gas companies within a certain radius of some convenient center, through the managers of the contributing companies, elect a management to operate a plant for utilizing and disposing of all residuals. It would then pay to carry on an extensive works for this purpose.

Competition would then be reduced to a minimum, and our companies would get the benefit of all that could be obtained from this source.

In the years previous to the formation of our conventions, managers, or those in control of the gas companies, did not acquaint themselves sufficiently with the operations of their

neighboring companies. They visited each other, perhaps, but there had not grown up between them that open, free exchange of ideas and results that an association of men generates.

Consequently, progress in the profession did not begin to be made with anything like the rapidity that it has since.

Although very generally acknowledged now as necessary to the success of any company that its managing officers should attend these meetings to gain such information as they find it possible, yet, I believe, some companies do not yet recognize its importance. It is one of the most serious mistakes that can be made in the proper management of any industry, to not give its manager every opportunity to learn, no matter how little, of that which will benefit it in the least.

Let us attend these meetings; make it our business to visit other works at least once a year; subscribe for and read every periodical bearing upon our business that time will permit, and be sure to make time for the most important. Let us not think, because we have visited a certain works once, we cannot learn anything by going again. That works is perhaps undergoing improvements, and may be working out ideas that have not occurred to us. If we follow these ideas we will not rank among those "mismanaging" gas works.

Thus far there have been enumerated, probably, the most important of the ideas which should be brought to the notice of the management of our gas works. Attempt has not been made to criticise the management of the detail in operating a gas works. It seemed best to leave this for others to undertake. Much of this detail is a question of conditions and opinion, and I believe a number of equally well managed works might have as many methods of carrying out the details.

In general, those works that are properly arranged in the first place, where sufficient care is given to the quality, where machinery is introduced in every place where it will pay in that particular works, so that all the labor possible is dispensed with, where all the labor and the apparatus of the works is conducted under a proper system, where sufficient attention is given to the measurement of and to the condensation of the gas manufactured, where economy is practiced in all departments, and sufficient attention is given to the disposal of resid-

uals—in such a place the works will be well managed let the detail be carried out as it will.

Discussion.

The President having temporarily vacated the chair, the chairman pro tem. (Mr. A. E. Boardman) said: You have heard a very able and a very valuable paper from Mr. Cowdery. It is now open for discussion.

Mr. Littlehales—I have listened to the paper with a great deal of pleasure; but I think it is somewhat misnamed. I think the title should have been, "How to Manage Gas Works Efficiently," instead of being the "Mismanagement of Gas Works." Of course, while the converse holds good, that a lack of those qualities which the writer of that paper has suggested means a mismanagement of the works, yet, I would have liked to have had it more definitely pointed out where the particular items of mismanagement come in in gas works. Unfortunately a great many of those points are such that a practical manager cannot control; and a great many of those arise from the directorate who look at the thing from one standpoint, while the practical manager who is responsible for the results has to look at things from a totally different standpoint. The directorate usually look at it from the shareholders' point, and never come in contact with the consumer; whereas for the whole result in the case of any failures, or in the case of the price of gas being kept too high, the man at the office has got to stand all the racket of it, and occasionally gets it in pretty liberal doses. The point in the paper about there being a unit of management I entirely agree with. I think that some man who comes in contact with the public, and who knows the whole ramifications of the business, should, as far as possible, have the whole control, certainly of the methods adopted and the policy carried out. Of course, so far as the management of the finances is concerned, that must be in the hands of the directorate.

Another important point from my view, and which is perhaps the cause of a great many difficulties that arise in our business, is that works are often entrusted to the hands of men not at all trained in the gas business. Now, we know that it is within the

ability of the average business man, if he has time enough, to learn the gas business the same as anything else; but in the meantime, while he is learning his business, the consumers are having to pay for that education. Mistakes are often made through a false economy; as perhaps thinking to save a little on the salary of a skilled man, the works are entrusted to an unskilled man, and the result is mismanagement—not an intentional mismanagement, but simply from a lack of experience that must produce mismanagement. And there is another point where I think mismanagement often arises. I think that every foreman should have charge of his own men—of the appointment of those men, and the discharging of them. I know that that is often done in the office; but my own experience has led me to adopt another rule, and I have found it to work very well. If you want a foreman, either in the works or of an outside department, to take a thorough interest in his work, he must have charge of his men; for he is often in a better position to tell which man is most efficient in his special work, or more apt, than the superintendent; and if he has the control due to his position, I think you would often find very much better results obtained. It gives the man a greater interest in his department, and more attention is paid to it. Now, if a man—a workman, we will say—is sent to the foreman from the office, it will often happen that the foreman has no control over him, and there is not as good a result obtained. I think that is one feature of mismanagement. I think it would be better policy from that standpoint if the practice were adopted of letting each foreman of a department have entire control so far as the employment of men is concerned. There is another point of mismanagement, especially in small gas works. We all know how important it is to have the retorts well set. In small works, perhaps in a majority of cases, some local bricklayer is employed to set the retorts. It would be better management to send two or three hundred miles for an experienced retort setter. You would save the extra expense in the wear and tear of retorts. I have often found it the case in small works that an average bricklayer, accustomed perhaps to throwing in joints half an inch thick, would be employed; but instead of their being any saving, the ultimate loss would be three times over the

cost and expense of bringing a good man to do the work. That is one point of mismanagement, as it strikes me. Another point is in the lack of system in bringing in the meters regularly. Now, however good the meters you have may be to start with, where they are worked intermittently more or less of the number will get out of order and allow gas to pass. Some companies bring in their meters very regularly and systematically, and examine them frequently; other companies do not. I think these are like points of mismanagement where the actual items could be pointed out. My own experience is that you cannot bring in the meters, too often, within reasonable limits; and that there should be some regular system by which you will know when every meter has been brought in and overhauled. In many of these little ways, if a systematic course is pursued, we would get very much better results. Another thing I was very glad to notice in the paper was the importance of giving prompt attention to all complaints. I have met with cases where (very much like what the President said in his remarks) there was a lack of attention even when customers went to the gas office. I entirely agree with those remarks. The first thing should be to let everything else stand and attend to those who come in. My instruction to our clerks always is never to let a man leave the door or the counter, if it is possible to satisfy him in any shape or form. Whatever time is necessary to do that, even though it takes an hour of a clerk's time, should be taken. Employés sometimes hesitate to give that necessary time. My own experience is that no time is better spent by the clerks or in the manager's office than that which is spent in trying to satisfy customers by listening to their complaints and trying to remove the little difficulties. Often a call from the superintendent himself will straighten a difficulty out, for the customer feels that he is being treated well by reason of the mere courtesy that is shown him. I think these little matters must and will recommend themselves to every one of you, and I think the man who will practice them will accomplish a great deal of good.

Mr. Somerville—One point of mismanagement which I think is worth dwelling upon is in the matter of distribution. We all bestow a great deal of attention to the making of our

gas, to making the gas good, and to making the gas chemically pure; and then some lose from 10 to 15 per cent. of it in distribution. Now, that is what I call mismanagement. I do not know of a place where we can bestow attention with better results than in seeing that our mains are laid sound and tight, so that instead of losing the gas we may sell it to consumers. I have actually known of cases where the pipe laying has been let out to contractors at so much per foot; and the directors of the company thought they were doing a great thing, and making a splendid job, when they put a man to doing the main laying for about one cent per foot cheaper than it should cost them. They thought it was a good trade; but we know the result of that sort of thing. They put the pipe down, cover it over, and go on to the next; and then when the gas is turned in they find that it has to be done all over again, or if it is not done over again, it ought to be. This is a point that I would like to impress upon all—to look out for the main laying. Try not to lose a foot of gas if it is possible to avoid it. I hope the day is coming when this matter of leakage will be a thing of the past; that we will be able to direct our energies to getting sound and tight pipe that will retain the gas. There is some talk about wrought iron pipes, and I think it is a good idea. We want to do anything that will stop this leakage. It is wrong for us to have any such thing as leakage in these days. Mr. Littlehales' remark about meters is very good. Bring in the meters very often. Do not wait until they stop, but bring them in regularly and test them.

Mr. Lansden—I think this reference in the paper to pumping air into the mains may be, to outsiders, misleading to some extent. I hardly think Mr. Cowdery meant to describe the way that he introduced air into his gas, but to describe a method of revivifying the oxide, as I understand it. We all believe that the least possible portion of air in the gas is an injury. We all understand why he introduces a certain portion of air in the oxide in revivifying. I do not like to have it go out that gas companies are doing what they have been accused of doing for the last 25 years—pumping air into the gas—without having it appear why some of us who use a certain method of purification introduce air to revivify the oxide; while others of us

who use lime purification are still able to swear that we do not use any air.

THE CHAIRMAN—I think it is very proper that the paper, and the remarks upon it, should be brought to the notice of our boards of directors, and that the paper will do much good in that way, as it will undoubtedly be brought to their attention by the engineers who are here present.

On motion of Mr. Egner the thanks of the Association were voted to Mr. Cowdery for his paper. President McMillin resumes the chair.

COMMITTEE ON PLACE OF NEXT MEETING.

THE PRESIDENT—I think it would be well to provide a committee to select a place for the next meeting of the Association before having the next paper read.

On motion of Mr. Greenough the President thereupon appointed the following gentlemen to serve as such committee: Messrs. John S. Bush, Isaac Battin, T. Littlehales, H. C. Adams, and Henry B. Leach.

THE PRESIDENT—We will now listen to Mr. Forstall's paper.

Mr. A. E. Forstall, of Chicago, Ills., then read his paper on

THE PURIFICATION OF GAS.

The manufacture of gas would be a very simple matter if the products of distillation came from the retorts or generators, in a fit condition to be passed directly through the station meter to the holder, ready for immediate distribution. Unfortunately this is not the case, the crude gas containing components that must be more or less completely eliminated before the goal of a salable article can be reached. Every operation to which the gas is subjected in its passage from retort to meter, has for an object the removal of one or more of these impurities, therefore, all steps in gas manufacture, after the accomplishment of distillation, are properly included under the head of purification. They may be subdivided, according to the nature of their object, into two classes. First, those for the condensation of

the heavy hydro-carbon vapors present in the highly heated crude gas, but which the same gas, at lower temperatures, is unable to hold in suspension; and, second, those for the removal of fixed gases, which are deleterious either in themselves or by reason of forming noxious compounds when burned. The first class, employing mechanical and physical means, friction and change of temperature, is known as the process of condensation, while the second, working by chemical reaction, comprises the operations of washing or scrubbing, and that final one to which in ordinary nomenclature is applied the name of purification, though it is really only a single step in the long series of purifying operations. Either on account of this arrogance of name, or because being an intermitted process it obtrudes itself more upon our notice than the others, which will, to a certain extent, run themselves, I think most of us commit the mistake of devoting extra energy to this branch of purification that might more profitably be given to condensation and scrubbing, and it is to these that I wish to call your attention.

The successful solution of any problem is dependent upon a clear comprehension of the object to be attained, and a knowledge derived from the properties of the substances to be acted upon, of the principles involved. In condensation, the objective point is the complete, harmless, and facile removal from the gas of those vapors, the deposition of which, inevitable under conditions certain to be met during its passage through the works and mains, will cause great annoyance, and damage the illuminating power of the gas, if not effected at the proper points and in the proper manner. At the same time, no hydrocarbons should be taken out, that the gas can be made to retain with advantage. Condensation is perfect only when the gas leaves the apparatus containing just enough hydro-carbon vapor to fully saturate it at the minimum of temperature and maximum of pressure to which it is to be subjected in the future. This, then, is the result to be sought, and the general principles to be followed for its attainment have been the subject of much experiment, by which the truth of the following seems to be well established. All heavy tar should be removed from the gas while it is quite hot, at any rate above 100° F. Contact between gas and heavy tar should be reduced to a

minimum, and under no circumstances should the gas be allowed to bubble through tar. Contact between gas and the lighter tar or oils is not detrimental, and in some cases has seemed to be beneficial when occurring at moderately high temperature. Sudden chilling of the gas is to be avoided, especially during the last stages of condensation.

These principles necessitate the observance of the following points in constructing and arranging the apparatus. The hydraulic main should be so designed and taken care of as to preclude any possibility of the gas having to pass through tar, provision being made to keep the dips always sealed in liquor. The foul main, in which there is unavoidably more or less contact between gas and tar, should be so protected as to prevent any marked fall in the temperature of the gas while passing through it; and, if very long, the tar should be drawn off at several points, thus diminishing the length of contact. Some species of tar extractor should be placed before the condenser, to free the gas from all heavy tar before the final cooling begins, leaving only the lighter oils to be brought down at the lower temperatures. The reduction of temperature from the outlet of this extractor to the outlet of the condenser should be very gradual, the condensed liquids being drawn off at each stage of the process to prevent the contact between them and the gas as it cools, these oils possessing the property of absorbing, at the expense of the illuminating power, vapors that would otherwise remain in suspension. Atmospheric condensers are not as efficient as those using water, not being under as perfect control as the latter. The area of radiating surface should be large enough to permit the cooling to take place with a maximum difference of five degrees between the gas and water at any given point, and the smaller this difference the better will be the work done. With a properly designed condenser, the final temperature can be advantageously kept lower than is usually the case, though, of course, no benefit is to be derived from making it lower than the lowest temperature the gas will reach in its future progress.

These data have been established by observation and experience in handling coal gas, but there is no reason why they should not apply equally as well to carbureted water gas.

Affectionately yours

Theob Forstall

Practically, the same mixture of hydro-carbon gases and vapors is under treatment, the tar formed when crude oil is used being almost identical with coal tar; so that methods of condensation proved to be the best in one case should also be best in the other. In most water gas works very little attention seems to be paid to condensation, the only care being to make it thorough enough to save trouble in the purifiers, and at the consumer's burner.

There has been no incentive to do more from the pecuniary point of view, as until lately the residual tar has had no market value, and the loss of illuminating power due to improper handling at this stage of the manufacture does not come home as a question of dollars and cents. However, as even ordinary coal gas, when improperly condensed, has only three-quarters of the theoretical candle power it might be made to possess by perfect treatment, and as the damaging effects of bad treatment increase rapidly as the gas becomes richer, it can easily be seen that the loss may be a very serious one. Up to the present, the increase in yield of candle-feet per gallon of oil, that has gradually been obtained since the introduction of illuminating water gas, has been almost wholly due to improved methods and care in distilling the oil. But we have also a rich field for improvement in condensation, one that will well repay time and money spent in its development. Combined effort along both lines, distillation and condensation, may change the present ideas as to the illuminating value of a gallon of oil very materially.

However, whether treating coal or water gas, it is not sufficient that the apparatus should be improved in construction and arrangement. The most perfect apparatus will not take care of itself, and good results depend upon continuous, careful vigilance. Thermometers and pressure gauges should be placed wherever it is important to know what is taking place. Especially is this the case with the condenser, where a knowledge of the temperatures of both water and gas is absolutely necessary for intelligent working. Having provided the instruments, it should be made the duty of some particular person to read their indications at regular intervals, and adjust the water supply accordingly, with reference, not only to initial

and final temperatures, but also to the regular and gradual decrease from one to the other, and the comparative temperatures of gas and water. With a properly constructed condenser this can be very easily done. A record should be kept of the average daily temperatures along the whole line of the condensing plant, which should be as carefully looked over and studied by the manager as is the record of any other operation involved in gas manufacture. Just as much attention should be paid to securing the best possible gas from the products of distillation as is paid to increasing the volume of these products.

Having the gas properly condensed, it is now, in the case of coal gas, to be put through the washers or scrubbers. With water gas there is no analogous step, the so-called washers used being really tar extractors. The main object of this operation is the complete removal of the ammonia present in the gas, but it must not be supposed that this is all that is to be done. There can be no greater mistake. The real problem is the removal of the ammonia in combination with as much of the carbonic acid and sulphureted hydrogen as it can be made to take up, thus reducing the work of the purifiers to a corresponding extent. When oxide of iron is the sole purifying material used, it is most important to saturate the ammonia with carbonic acid, and so increase the illuminating power. Unfortunately, however, there is no control over the relative amounts of carbonic acid and sulphureted hydrogen taken up, all that can be done being to make sure of the saturation by both acids, and preferably to form as far as possible those compounds in which one atom of ammonia unites with two of acid. As the carbonates and sulphides of ammonia are readily decomposed by heat, carbonic acid and sulphureted hydrogen being given off, it follows that the temperature should be kept low as possible during the scrubbing.

It is also advisable to use in the scrubbers the liquor from the hydraulic main and earlier stages of the condensation, as containing a large proportion of uncombined ammonia it will take up a corresponding amount of acid impurities. However, the scrubbing should be completed by the use of water free from ammonia, as in no other way can this be totally eliminated, and unless very cold water, or an immoderate quantity

is used, the effect on the illuminating power will not be appreciable. The contact between gas and liquor must be made as complete as possible, and the time should not be cut too short. Here, also, records should be kept of the progress of the operations, samples of liquor being drawn off at various places and tested for contained ammonia and acids. Only in this way can we be certain of doing our best. Before there can be any hope of improvement in working, there must be an accurate and thorough knowledge of what is being done. Constant tests at all stages of the progress of the gas through the apparatus, are absolutely necessary for the attainment of the best results, and attention cannot be too often called to their value and importance.

I have confined myself strictly to outlining principles without any application of them to particular forms of apparatus, as I consider it of the first importance that we should have clear, well-defined ideas of what is to be done, and how it is best done, and also think that these can be better obtained by approaching the question from its theoretical side. When we begin to treat of special machines, our prejudices and prepossessions are very apt to come into play, clouding our minds as to the real points at issue, but the true theory established, the application will follow as a matter of course. I have, therefore, endeavored to make plain the theoretical ends, towards which we are striving, with the theoretical lines along which our efforts should be directed to make these ends attainable, being confident that if I could succeed in fixing attention upon what ought to be done it would not take long for each one to put theory into practice, in the shape best suited to the conditions imposed by his own circumstances and surroundings.

NOTE.—On this subject see The Report of the Council of the Gas Institute for 1883, in the Transactions for that year; also, vol. 41, page 1084, of *Journal of Gas Lighting*, etc.; The Chemical Theory of the Production of Illuminating Gas, by M. Gueguen, vols. 43, 44, and 45 Ibid; Some notes on Gas Liquor and Ammonia Purification, by Lewis T. Wright, Ibid, vol. 48, page 280; Condensation, by M. Alavoine, Ibid, vol. 48, page 65; also, Journal des Usines a Gaz, 1885, page 2,831; Condensation, M. Coze, Ibid, 1886, page 212; Lavage et Epuration du Gaz, Ibid, page 213; also, the Compte Rendus du Societe Technique du Gaz en France, for these years; Condensation, by R. B. Taber; Proceedings of American Gas Light Association for 1885-1886, page 202; also, American Gas Light Journal, vol. 45, page 213.

Discussion.

The President—We will now discuss the points suggested in the very able paper which has been read in your hearing. I hope that modesty will not prevent any one from speaking.

Mr. Greenough—I do not want this paper to pass without expressing my appreciation of it. It is a very carefully thought out paper, and it is a great pleasure to have young Mr. Forstall read to us so good a paper as is his contribution to this special occasion. It shows the training that he has had, and the care with which that training has been applied. What he says about the condensation and purification of coal gas is, I think, substantially true; and I think there is no portion of a gas company's business which is more frequently slighted. What Mr. Forstall says about the necessity of watching the temperature is most unquestionably correct; and yet I have in mind a visit paid not long ago to one of the largest, if not the largest, gas works in this country, and on my asking some question about temperature I was told that there was not a thermometer in the entire place—which is, in my judgment, as much as saying that the whole business of purification by that company was carried on absolutely without careful management from beginning to end. I have nothing further to suggest than to express my appreciation of the paper.

Mr. Littlehales—I am sure that every member of this Association has a pleasant recollection of the name of Forstall in connection with the Association, and I can only say that the paper just read does credit to the name. I am sure if the ex-President of this Association could look and see what is going on he would experience a great amount of gratification to see his son following so ably in the footsteps of one whose memory shall always be cherished by us, and showing such excellent promise for the future. (Applause.) I agree with the paper, in the main. I would like to ask Mr. Forstall if he had come to any conclusion as to the relative importance, or the relative cost of lime or oxide, or of both combined? I have had some experience in the three methods. With lime alone, with oxide alone, and with lime and oxide together. I found some years

ago in purifying that we were doing pretty fairly as we thought in purifying about from 5,000 to 6,000 feet per bushel of lime. Our boxes were very small in proportion to our make, and the gas was rushed through very rapidly. We put in a larger set of purifyers—very large as some would consider, in proportion to our make—and this enabled us to carry out the system which is generally adopted across the Atlantic, using the lime for the carbonic acid, and using the oxide for the sulphureted hydrogen. In the last year that we used lime exclusively our cost for purifying material was about $1,800, or equal to 3.8 cents per 1,000 feet made. The next year we had got in our oxide (and I may say that we used the natural oxide), and that year eight months were with lime alone, and four months with the oxide and lime in the manner indicated. We charged one-quarter of the cost of the oxide to that year, assuming that the oxide would last four years—we find that it will last very much longer than that; but we assumed that it would last four years, and consequently charged one-quarter of the cost. That reduced, for this year, our cost from 3.8 cents to 1.9 cents, or from $1,878 to $928. The next year, 1887, was the first year that we had fairly working and under way the new method of lime first and oxide second, and our cost for that year, for 47,962,000 feet, was $285.70, or .6 of a cent per 1,000. In 1888, for 52,809,000 feet, the cost was .4 of a cent. The oxide did more work in the second year than it did in the first. We almost invariably find that with the native oxide, after it has been in once or twice it runs a longer period than it does the first time it is put in. Our cost that year was .4 of a cent. The next year the rate was the same. For the year ending January 31st, 1890, the cost of the purifying material was $182 05, which was .3 of a cent per 1,000 feet. For this current year, having only $167 still standing against the oxide account, it will cost us as near as I can estimate, for the few weeks remaining of our financial year, .2 of a cent per 1,000 feet. That is pretty low. It has this additional advantage—that I am perfectly sure that the oxide will last two years more, and during that whole time it will cost us absolutely nothing for material. We do not revivify it in the boxes, because while that is perfectly practicable, I find there is a tendency to a little caking of the oxide, and I find it does better to

take it out occasionally than to revivify it in the boxes. If I did revivify it in the boxes, I would never think of putting air in with the gas; but when the gas was turned off I would run a little steam and air through the boxes. I would never think of putting in the air with the gas for the sake of getting one-fifth oxygen out of the air, and having four-fifths nitrogen going off to dilute your gas—for that is where the trouble comes with the air process. I think you will not find many places where the purification has been done more successfully and cheaper than is shown by the figures I have given you. I have no doubt, as Mr. Forstall indicates, that the time will come when the oxide will be in such demand for making sulphuric acid and other sulphur products, that it will be worth just as much as the original cost after being used for purifying. There are many works in London that get their oxide supplied by the sulphuric acid makers, and taken away after use, free of cost, because of the sulphur which it contains. When they want to make pure sulphuric acid they usually get the sulphur from the sulphur mines of Sicily, and it costs probably $40 per ton. Now, an oxide can be run up until it contains from 45 to 55 per cent. of its weight of sulphur, in which case it should be worth half (or about one-half) the amount of sulphur. So you see that by-and-by, if a sufficient number of companies are purifying by the oxide methods, the same companies will no doubt be interested to recover the sulphur from the oxide, and then will make the oxide a merchantable article. I know that there is a great difference of opinion as to the relative merits of the natural oxide and the manufactured article. My own experience is altogether in favor of the native article. You have it distributed over large areas in the United States, and we also have it in Canada; and I am perfectly certain in my own experience that there is no comparison between the two results. I find that the quantity we have purified per bushel since we have had it in operation is something pretty large. I have here the figures of what we have passed through it, per bushel and per ton. During the whole of this year, from January 31st up to date, we have simply changed three boxes of lime and three boxes of oxide. That is rather a small number for nearly a year's work. For the whole year ending January, 1890, we only changed four

oxide boxes and six lime boxes. That is rather a small number.

Mr. Greenough—What is the size of your boxes?

Mr. Littlehales—The purifiers are 20 by 18 by $4\frac{1}{2}$ feet. That is a point that I want to call the attention of the Association to. I think that there has been a tendency to unduly curtail the size of the boxes. I have been asked on several occasions with reference to small works that I was constructing or reconstructing, "What is your rule for calculating the size of the purifiers?" One simple rule is the financial ability of the company to build large ones, and that is the general rule that I pursue. I think very few of us realize, until we come to test the thing practically, what a difference in result there is when we work the boxes very slowly. It is almost impossible to purify the gas when it is pushed through rapidly. The purification of gas is necessarily a chemical operation—time is required to do it properly; and when the gas is rushed through rapidly there is no chance for it. I think the size of the boxes is a matter worthy of more attention from members than it has received. I do not attribute all of our success at Hamilton to the method, but partly to the very large size of the boxes, and I am sure the members will find that they will work more economically in every respect by having more liberal purifying space than is the usual rule.

Mr. Harper—I have listened with great attention, and interest to Mr. Forstall's paper. He seeks to emphasize points which are very generally known here, but which are not by any means generally practiced. The subject that he has brought before us to-day is one of the greatest possible importance. I do not want to take up time in discussing it, but I would like especially to emphasize the importance of that part of his paper where he deals with the thermometer. I think that that point is of very great importance indeed. I shall be inclined to call that scientific practice as distinguished from scientific attainments. It is my impression that our business would make much more rapid progress than it has done if there were a more general idea of the chemical operations involved in the department of purification which Mr. Forstall has dealt with. It is evident to us all that here a greater or less knowledge of

chemical operations is involved. It appears to me there is no business of the magnitude and importance of ours which has so little literature of a chemical nature as ours has. I think it is of very great importance that this literature should be obtained rather by experts in the profession than by someone outside of it. It seems to me that the words "gas analysis," or anything of that kind, are a pretty large stumbling block to the average gas manager; but it seems to me that a man does not require to be really an expert chemist in order to do a great many of the things that are necessary to be done in properly managed gas works. A great deal of that, as you are aware, is more or less of a mechanical operation than otherwise. I saw in a book not long ago published, in which a man sits down to address gas managers, the statement that "coke is a black, solid carbon;" and a few pages further on it speaks of a "standard acid," and there are similar phrases given as being things well known to chemists. It appears to me that that is the very thing that we want to know, so that we may not have to presuppose. I think that a man might just as well sit down and tell us what he means by a standard acid, how it is prepared, what it is used for, and how used. And the same as to gas analysis. The analysis is simple; its operation is simple; and I think that we can understand what is meant by a "concentrated solution," and what is meant by a "moderate concentrated solution." I think that a man would derive a great amount of benefit from the information, and he would know that he was on the right track; and, therefore, I think that our business on the scientific side is one which, if properly developed, can be very rapidly advanced.

MR. LITTLEHALES—I have here the figures as to the amount of gas that we have purified by the oxide up to the 10th of October, 1890. We have purified, per ton of oxide, 4,857,700 feet, or, as the bushel weighs about 80 pounds, it is equivalent to 194,305 feet per bushel. That is the result at our works.

MR. SLATER, JR.—To revert to that branch of purification of which the paper read by Mr. Forstall treated, I would like simply to call attention to one fact with regard to condensation, and that is—in most works, and especially those of older con-

struction, we find that the condensers are designed simply to cool the gas down to a certain temperature, apparently without regard to what happens in the gas during that process. In some works different varieties of coal are used, all put through the same process of cooling the gas, and various results are obtained, which, with proper attention to condensation, might be changed; so that some coals which in certain works bear a very high reputation, might be made to show very low results, and others that show very low with some few, might be made to show more uniformly with others. In connection with bad condensation, there is another much mooted question which has been considered before the Association, and that is the question of napthaline. I think it will be generally found that one of the most commonly recognizable causes of the formation of napthaline would be the cooling, particularly the sudden cooling, of gas containing more or less moisture or aqueous vapor. Where the condensation is done very rapidly, although the gas may be successfully cooled to 60°, if that is done very suddenly, and the gas contains much moisture on entering the condensers, the almost invariable result will be plenty of napthaline in the condensers. But if the condensation is imperfect, and the gas is not cooled to a proper point, then of course the natural expectation would be to find napthaline at such points in the progress of the gas as where the temperature was reduced. I think that the point of slow condensation—not merely to reduce the temperature to a given degree, but to cool the gas very slowly—is a point that many of us would do well to consider.

THE PRESIDENT—Will Mr. Scriver tell us about the oxygen process in Montreal?

MR. SCRIVER—I have no information to give you with regard to the oxygen process, as we have not yet got it in operation. We are now constructing our works, and expect to be through with the construction in about three weeks. Down to the present time I cannot say anything about the effect that it is going to have upon our gas. We heard something about that last year. I think the information that we obtain in this way is very valuable; but at the present time we can add nothing to it.

THE PRESIDENT—You may consider yourself booked for a paper on that subject at the next meeting.

MR. GEGGIE—I think the point Mr. Forstall made, having in view the purification in closed vessels, is a very good one. I hope he will continue on in the good work until we get rid of lime, and oxide, and all these other things. I think also that his remarks on condensation are very correct. I think slow condensation is of great benefit to the gas. In my works I have two condensers, passing the gas first through an annular condenser, and then through a scrubber condenser. I do not have any napthaline at all, and never had any stoppage because of it. I attribute its absence altogether to the slow condensation. I think if we would pay more attention to condensing the gas slowly, and quit rushing it through so rapidly, we should have no further trouble with napthaline.

THE PRESIDENT—I think there are many gentlemen here who would take pleasure in introducing you to the napthaline. Are there any further remarks? If no one else desires to speak, Mr. Forstall will reply to the remarks which have been made.

MR. FORSTALL—I would like to ask Mr. Littlehales if the figures which he gave were for just the expense of the oxide.

MR. LITTLEHALES—For the purifying materials alone.

MR. FORSTALL—Does that include lime only, as well as both lime and oxide?

MR. LITTLEHALES—In all the figures given the cost of the purifying material was referred to, whether that was lime alone, or lime and oxide together.

MR. FORSTALL—I have had no experience at all with the use of lime and oxide together. We used lime at first, and then we changed to all oxide. The figures for the oxide averaged with us about 1 cent for labor, and 0.7 to 0.8 of a cent for material. Of course, in the case of lime it was much greater. I think that Mr. Littlehales' results are largely due to the size of his boxes. We had at one time a new purifying house with a capacity of two million feet per day, and only passed 600,000 feet through it; and I did not have to change the purifying

boxes more than once in three weeks, or once in a month. We started and worked it up to 1,800,000 feet, and then changed that same material in the boxes, sometimes every two days, and sometimes every day, so that the change was much greater in proportion to the amount of gas going through—changing much oftener than could be expected from the amount of gas passed. I want to express my thanks for the very kind remarks of Mr. Greenough and Mr. Littlehales.

Mr. Shelton—I think that we can do no less than to extend a very hearty vote of thanks to Mr. Forstall for not only a most instructive paper, but for an extremely well written paper. (Adopted.)

The President—Gentlemen, I want to return you my sincere thanks for the interest that has been manifested here this morning, for the order that has been kept, and for the system that all have observed in the discussions. If the members will all be kind enough to address the President, and wait for his recognition before they begin to speak, I think we will make better progress. That has been done this morning, and I hope it will be continued. On the second page of the printed programme I find in red ink this little paragraph: "Pay your annual dues at this time at the Secretary's desk in ante-room 104." The hour for adjournment having arrived, we will now take a recess until 2 o'clock.

First Day—Afternoon Session.

The Association was called to order at 2 o'clock, and the President introduced Mr. Frederic Egner, of St. Louis, Mo., who read his paper on

INCLINED RETORTS.

Our subject is one to which the attention of gas makers has been frequently invited of late years, and when the Council of Administration of the American Gas Light Association honored me with an invitation to prepare a paper with the above title, to be read at the eighteenth annual meeting, these gentlemen prob-

ably were informed that the Laclede Gas Light Company had in course of erection a stack of benches to be fitted with retorts in the inclined position, and was spending a large sum of money on apparatus which was at that time still regarded by many very much in the light of an experiment. The completion of these benches has been delayed beyond all reasonable limits, by the firm which had agreed to furnish the necessary iron work; so much so, indeed, that although it was expected that some of the benches would be under fire by the middle of last May, it was well in September before heating up could be commenced. Hence my experience with that kind of retort setting is not extensive; but the facts and figures gathered, and observations made, are herewith presented, in the hope, on the part of the author, that you may find them interesting enough to compensate you for the time spent in listening to or reading them. We find "Inclined Retorts" spoken of in "King's Treatise on Coal Gas." In a paper read before the Western Gas Association, by Mr. Henry Pratt, May, 1888, and published by the gas journals of that day, we are given some historical, theoretical, and not a little practical information on the same subject, which was again brought before the same society by Mr. R. D. Walsh, a year later. The *Scientific American* Supplement, of Nov. 28, 1885, contained an illustrated description of "Coze's System of Gas Retorts," giving a very fair representation of the system as developed at that date. Prior to this, viz., July 28, 1883, the *Scientific American* printed an article in which an inclined retort was shown in connection with a water gas generator, and quite recently profusely illustrated papers have been published in a number of technical journals, stating almost everything that can be said about inclined retorts, so that one can hardly escape the suspicion of plagiarism, however unfounded, when writing anything at all on that subject. I will, therefore, confine myself to simply describing to you the so-called inclined benches which were erected at one, and give you the comparative results obtained from a bench in operation at another, of the works under my charge.

About two and one-half years ago, a bench with five inclined retorts was put in operation at the works of the St. Louis Gas Company. These works are now known as "Station A" of the

Laclede Gas Light Company, of St. Louis. This bench is located by itself in a shed alongside of one of the retort houses, but is connected with the principal gas mains of said house by means of a 12-inch pipe. It is 10 feet 9 inches wide; 13 feet 5 inches long; and 16 feet 2 inches high. The retorts are "D's," 15 in. by 23 in. by 11 ft. 3 in., set at an angle of about 30°, and are heated by means of an ordinary retort bench furnace 14 inches wide and 5 feet deep.

The retorts were charged the first time on May 1, 1888, and were in continuous operation for a little over two years, when the bench was let down, the furnace relined, and one of the coal charging chutes, which needed it, repaired; then the bench was again fired up, charged, and is doing good work now, everything considered. At present we coke 9,400 pounds of Pittsburgh coal in that bench in 24 hours, using 24.06 pounds of the coke to each 100 pounds of coal carbonized, or about 40 per cent. of the coke made. The greatest amount of coal carbonized in 24 hours was 11,500 pounds, with the same proportion of coke used.

We have some benches of 5's (with horizontal retorts, of course) at another station. The retorts are 14 in. by 22 in. by 8 ft. 3 in. D's, with the same kind of furnace as that mentioned before, excepting that it is only 4 ft. 6 in. deep. In these benches we carbonize 7,950 pounds of coal per diem, using 23.94 pounds of coke to the 100 pounds of coal treated, or 38 per cent. of the coke made. In these benches we coke 99.37 pounds of coal per square foot of ground occupied, while in the inclined bench we carbonize at present only 70.07 pounds of coal per square foot. If, however, the latter bench was as favorably situated as our ordinary benches are, there would perhaps be no difference between the two in that respect.

Comparing the first cost of our ordinary, and the inclined bench of 5's, we find that the inclined bench requires about 741 cubic feet more of solid brick work; about 1,000 pounds more of fireclay settings; 50 per cent. more labor to set the retorts and iron work, and 5,705 pounds more of iron material. Therefore, if any of you would like to know approximately how much more an inclined retort bench would or ought to cost than a bench with horizontal retorts, you can get very close to it by

adding what the above items would cost you to the prices paid for the kind of bench you may now have. To this estimate there would have to be added the cost of the charging and coal hoisting apparatus; although Mr. Henry Pratt, whom I have quoted before, stated in his paper that he found that charging the retorts with a scoop shovel works very well; and I think the same could be done with a wheelbarrow; hence, even in a small works where there would be only one or two benches, the inclined retort system *could be* used without the necessary machinery desirable in the operations of a larger works. Mr. Pratt's opinion, based on his experience with the system, was that it would not pay to use inclined retorts in any works requiring less than 200,000 cubic feet per diem. Mr. Gimper, Manager of the gas works at Leavenworth, Kansas, and Springfield, Mo., is now engaged in solving the above question for himself at the latter city; and as Mr Gimper's friends know him to be a thorough gas man, both in theory and practice, it is not unlikely but that we shall soon get some valuable and reliable information on the subject of whether or not it pays to run only one bench of inclined retorts where only one or two benches are required. So far as works of the size of the Laclede are concerned, I can say that it would not pay to run only one such bench, if the men attending it could not be otherwise employed, which in our case they are. But the single bench has been valuable to us in a number of ways. We found without a doubt that a setting of inclined retorts would last as well as any other kind; that they could be scurfed, patched and heated as easily, and the charges as thoroughly and as quickly carbonized as the same in the common settings. And we found that with such settings the labor of drawing the coke and filling the retorts became such a simple and easy matter that anyone possessing the strength of a 16-year-old boy, and no more intelligence than a plantation darkey, could do the work after one showing, as well as the same could be done after years of practice in the ordinary way, by, our sometimes, a little unreasonable friend, the retort house fireman. He could not help but see that benches fitted with inclined retorts and heated by means of regenerative furnaces, would not only make a gas company about as independent of the retort house autocrat as a first-class water gas apparatus

does; but that it would forever do away with the awfully hard labor required of men making gas in the old way, and must result in economy to the manufacturer besides, even though the first cost of the benches was much greater. And that is why we determined to erect a stack of eight benches of 7's on the inclined retort system.

Limited space at that time only prevented us from building more than the number stated. The benches just now about completed at the old Laclede gas works, were built in accordance with plans made by the late Alfred Arndt, Engineer of the Chicago Gas Light and Coke Company, modified, and we hope improved, in some particulars, by alterations suggested by Mr. McMillin and myself. I have brought with me a blue print of the original design (see Fig. 34), and a drawing (see Fig. 35), showing the changes made by us. The original design of the settings of these inclined retorts was furnished by Mr. A. Coze, of Rheims, France, and Mr. Arndt's work consisted in adapting his regenerative furnace to Coze's settings. We made some changes in the brick and iron work, as can be seen by comparing the blue print and drawing referred to; and although we made these after careful consideration, we have yet to demonstrate by practical operation the superiority of our theoretical improvements, but hope to be able in the near future to decide that question affirmatively.

Before proceeding with the description of our new benches, I desire to call your attention to a few facts in relation to this whole system of inclined retort setting. We all know that the idea of setting retorts "inclined" is not new. A retort set that way, with a mouthpiece at each end, is described in "King's Treatise on Coal Gas," as previously mentioned. Some manufacturers of retorts assure us that if we want such benches, we can have them without regard to Coze's patent. Coze, in his United States patent, numbered 388,953, and dated Sept. 4, 1887, makes the following claim:

"*First.* The inclined retorts, *A*, placed one above the other, combined with the charging mouths, *B*, whose open ends are all on the same level, whereby the retort may be charged from trucks on the same level, substantially as set forth. *Second.* The foregoing specification of my improvements in retorts for

the distillation of coal and other solid matter, and in appara connected therewith, signed by me, this fourteenth day of M 1887."

Now, a person need not be much of an expert in patent m ters to know that the claim is weak, or of little practical val and from all that has been said and written upon the subje it must be plain to any one not willfully blind, that whoev cares to have inclined retorts can have them, without let hindrance from the owners of the Coze or any other pate But one thing no one should forget, and it is this: Th although the idea itself is old, it is one that had been aba

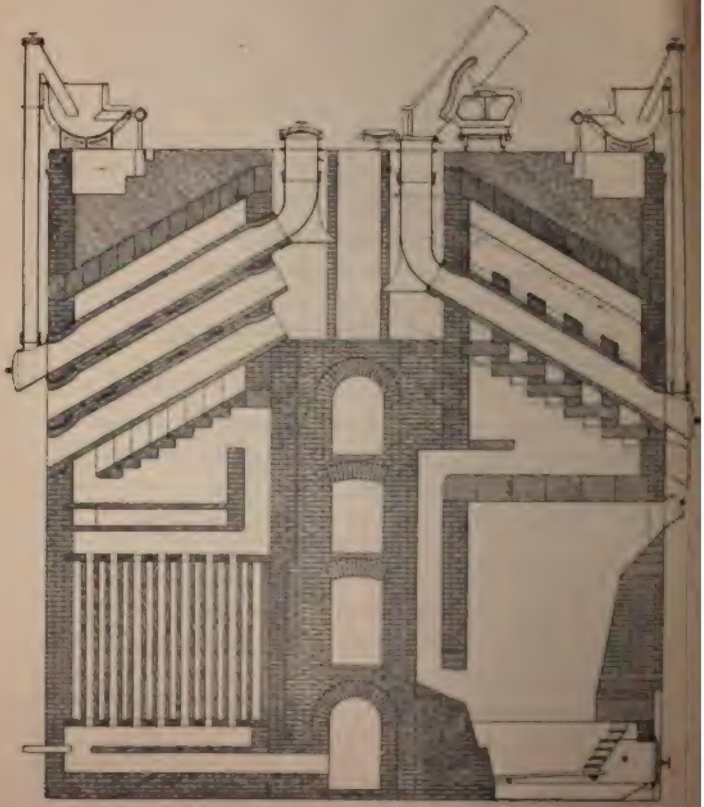


FIG. 34.

[redacted]

doned as useless; it had been forgotten and not considered worthy of a serious thought until Andre Coze took the matter in hand, and with the aid of genius, perseverance, and with the expenditure of much time and money, demonstrated to the world that the inclined retort was not the worthless thing it evidently was previously thought to be by everybody excepting himself. *Then, after* he had published to the world the results of his successful experiment, the customary imitators appeared. However, it is probably safe to say, that but for Andre Coze the inclined retort would have been suffered to remain forgotten; and for that reason he should receive substantial reward by all who will use inclined retorts, whether they make use of "Coze's patent," or adopt some modification of the originally dead idea, revived to the benefit of the world by our respected fellow-worker in the gas profession in far-away France. It should be a point of honor with all who can make successful use of inclined retorts to give practical recognition to him who did more than the original inventor with the inclined retort.

I will now proceed with the description of *our new benches.* The addition to our retort house, in which they were erected, is of the same width and height as our old house. The stack of benches occupies a floor space of 27 feet by 50 feet 5½ inches, exclusive of the chimney, which is at one end of the house. Less room is required between the wall and front of these benches than in the common setting, because the coal is delivered on top of the bench, and drawing the coke also requires less space than is required by the former. The distance from bottom of foundation to the floor line is 12 feet, 9½ inches, and from that point to top of bench is 16 feet, 11 inches. The arches are 9 feet, 8 inches wide inside, and 9 feet, 7⅝ inches long, from outside to outside, with a space of 7 feet, 9⅞ inches wide, and 8 feet, 10 inches high, between the rear ends of the retorts, thus forming a passage at the back of same, which is made continuous by means of arched doorways 18 inches wide, piercing the dividing walls between the benches. The space between the backs of the arches contains at its lowest point the main flue to the chimney, into which all the take-off flues of the benches enter. Above the flue, Arndt's

design provided for three arched, hollow spaces, not communicating, which were merely built thus to save brick; but Mr. McMillin thought these places would act as pockets, in which dangerous gases might accumulate, leading eventually to disastrous explosions, and advised to fill them up solid, which was done. The retorts, D's, are 16 inches by 22¾ inches at the mouthpiece, 14 inches by 24 inches at the middle section, and 12 inches by 22 inches at the upper or charging end, and 10 feet, 10½ inches long from inside of lower to inside of upper mouthpiece. The arches are closed up around the retorts with 13½-inch walls, so that 8 feet, 7 inches of its length is inside of the furnace. I hold that the effective floor surface of a "D" retort is that portion of it which is within the furnace walls, and that determines the gas making power of the same, if other conditions are equal. It is not the heating surface of the retort, as that is always bound to be great enough, compared with the area of the floor, of the style of retort mentioned.

Thus we find that the floor of our inclined retorts is equal to 18.7 square feet each, which is about the same as we could have if we rebuilt our old benches with horizontal "through" retorts. I fear I shall weary you if I go into greater detail with regard to these benches, and yet, if this paper is to be of any use, I ought to do it.

In order that you may readily be enabled to determine the possible benefits to be derived from the use of inclined retorts, the cost of their construction must be considered, comparatively with that of the horizontal retort.

Should we replace our common with regenerator furnaces, and instead of sixes, build benches of sevens, we would obtain the same gas making capacity, and require the same amount of substructure in such benches, as we have in our "inclines," that space of 7 feet, 9¾ inches between the backs of the arches alone excepted. We would have room enough in our retort house as it is, and could employ stoking machinery for filling and drawing our retorts. As to what would be the best thing to do—to use stoking machines or inclined retorts—we cannot say positively as yet. We know what can be done with the former, but not yet what saving can be effected by the latter

system of operating a retort house on a large scale. The far greater simplicity of the inclined retort system is a strong argument in its favor, however, and the greater first cost of the benches is after all for items which do not wear out easily, and can be used with many subsequent settings.

The first column below shows the quantity of material which was actually required for each bench, including the chimney, and for convenience of comparison I have given in the second column the same information of what would have been needed, had benches with horizontal retorts of same size and like furnaces been built, instead of the "inclines;" for very much of what may seem to be an excessive amount of material used, is due to the furnace, which would of course be the same for either style of setting.

	Inclined Retort Bench.	Horizontal Retort Bench.
Red brick..............	20,593.	7,500.
Building sand..........	6 cubic yards.	2 cubic yards.
Lime (80 pounds dry per bushel)	35 bushels.	12 bushels.
No. 1 fire brick..........	16,229.	12,000.
XXX No. 1 square brick.	575.	575.
Soap brick..............	650.	650.
Split brick..............	275.	275.
Arch brick and skew backs	730.	730.
Various shaped blocks and tiles..................	81,146 lbs.	74,896 lbs.
Dry milled clay..........	60 bbls.	48 bbls.
Ground brick...........	12 "	10 "
Retorts.................	7	7
All iron work complete..	21,884 lbs.	13,325 lbs.
Labor to build (two men)	105 working days.	35 working days.

The coal to be used is elevated to the top of the stack and delivered into hoppers by means of a link-belt and bucket elevator.

From the hoppers the wagonettes are filled, and the latter are then rolled opposite the retorts to be charged, and the coal dumped. From the time the first lump of coal enters the re-

torts until the lid is closed usually takes eight seconds. To remove the coke takes longer; but the labor is of such a nature that a man could do it with his coat and collar on, without inconvenience.

The coke dropping from the retorts is to be removed by a conveyer, operated by a steam or gas engine, to the coke store; but as we expect to make other improvements at our works next spring, that matter has been postponed for the present. I had hoped to be able to state at this meeting what results we obtained from these new benches; but as your Secretary informed me that he must have the paper by September 24th, I shall have to close without doing so; to which may be added that the benches may not after all be ready to charge at the date of this meeting. But we shall soon know what we can do, and by the third Wednesday of May, 1891, when the Western Gas Association will have its fourteenth annual meeting, at Louisville, Ky., a statement of results with the inclined bench, both at a large and small gas works may be looked for, and as the proceedings of that Association are published by the gas press, you will of course get that which I regret not to be able to give you now; and thus I leave the subject in your hands.

Having read the paper, Mr. Egner made the following additional remarks:

This paper was written about the 22d of September. Since then we have charged the benches. We would not have got them hot and charged them if it had not been for Mr. McMillin—for I was slow about it; but as he said to push them a little more, we pushed them to the point of working them. If I had this paper to write over again, I would probably make it shorter and more interesting; but as it is I have here a supplement which I wish to add to the paper, as follows:

Since the preceding paper was written the benches described were charged, and I can now give you some facts in connection with the practical working of the system on a larger scale than that with a single bench only. It is true, we have had only eight days of practical experience with our new benches with inclined retorts; but in writing about them I am reminded of the story about a little colored girl who, when asked how old

she was, replied: "I's most leben years old; but if I reckon the fun I's had, I's 'bout a hundred." We have had eight days of experience with these inclined retorts, but we have learned a good many things in those few days.

1st. We found that we can save about 35.3 per cent. in the number of men needed to handle an equal amount of coal (as compared with our old works) from beginning to end of the carbonizing operation.

2d. That, owing to the class of labor which can be employed, we can save 61.6 per cent. in money paid for wages as compared with the old system, and yet pay better wages by 12 per cent. at least than the same men could earn elsewhere.

3d. That there was an unmistakable prejudice among the men employed at the works against the new system, which prejudice did not stop there, but was given expression by a number of contemptible tricks played on the new apparatus and machinery connected therewith; and while the large majority of our men are honest, good, intelligent, and well-meaning, some one among them was a disgrace to the name of an honest working man—the latter the noblest creature on earth.

4th. That our retorts ought to have been set at a little greater angle, and that the curve of the coal chute at the upper and back end of the retorts should have been that of a parabola, and not that of a circle, as is the case with our coal chutes.

5th. That the coal chute castings should be carefully and very smoothly made. Any humps in the casting are a detriment to the successful working of the retorts.

6th. That if we had made our retort house a few feet higher and wider, it would have been much more comfortable for the men employed, and might have resulted in a further saving of wages.

7th. That in all other respects we seemed to have hit upon a good practical construction of the original idea of Andre Coze.

A number of other little so-called "tricks of the trade" were learned during our short experience. As these are likely to occur to any gas worker, I will not further take up your time by relating them here, but will only add that if I had the experience of the past few days *before* writing the paper, I daresay I could have made it much shorter and more interesting.

Discussion.

Mr. Mooney—I think there is a little error in Mr. Egner's paper, in the statement that Mr. Coze had revived a dead matter, as Mr. Cathels, a few years before his death, designed an inclined retort and a method for successfully charging and drawing the same. His first idea was to have a long chute for charging the retort, but after experiments at the gas works at Rockaway Beach, L. I., he adopted the plan of charging by means of a short chute and a double bucket—that is, a bucket within a bucket, the outer one emptying and the inner one following afterwards. The drawings were made by Mr. Arndt, and were obtained by me from Mr. Forstall a few weeks before his death.

The President—The drawings were made before the date of the patent?

Mr. Mooney—Yes, and were quite old drawings.

Mr. Littlehales—I can corroborate what Mr. Mooney has said, because the first experiments that Mr. Cathels made with reference to the angle of the chute were made in my own works. He was working on that for a long time, and it must have been at least three years before we heard anything of the Coze system that his drawings were completed. Hence what Mr. Egner says about their being free from any patent rights is perfectly clear.

Mr. Coggshall—I would like to ask the practical result of the eight days' work, in the amount of coal used, coke consumed, and gas produced.

Mr. Egner—We had arranged to run the gas through a separate meter, with an exhauster and a separate system of condensers, scrubbers, and purifiers. When the first six retorts were started, our exhauster stopped short, and we could not turn it over. We had run that exhauster the day before, just to see that everything was clear. We opened the exhauster then and found within it handfuls of cotton waste and ravelings of manilla rope, and several handfuls of iron borings. In the meantime we conveyed the gas another way and started

the benches. We could not run the gas made by the "inclines" through a separate meter, and for that reason cannot tell how much we made; but the coke comes out well carbonized. We have every reason to suppose that we got as much gas from the coal operated upon by the "inclines" as we would in the ordinary way, because the coal is thoroughly coked. The amount of coke that we use in the furnace is about 20 per cent. We charge 400 pounds of coal to a retort every four hours, and could charge more, because the furnace can be handled in any way you please. By opening the primary and secondary air drafts we could burn out the retort in a few hours. The coal we use will give 4.91 cubic feet of 17 candle power gas to the pound without an enricher.

Mr. Lansden—Will Mr. Egner give us his reason for changing the Coze system, with regard to taking the gas from the back end of the retort instead of the front? Coze takes the gas from the front; but I see by Mr. Egner's drawings that he takes it from the same chute where the coal is charged, at the back end.

Mr. Egner—I do not know that I am at liberty to use Mr. McMillin's name in connection with this, but he was consulted, and we thought that thing over very carefully. We thought there would be an advantage in changing, having in mind the system of Davidson, who charged his retorts only half way from the back end, and claimed to get better results by doing so. Of course he had the front part of the retort as a superheater, and he did get more gas from a pound of coal than had been got before when charging retorts in the then customary manner. About 17 years ago I was sent by the President of the gas company that I was with then, to investigate that system. You all know that when we charge a retort we shove the coal back from the mouthpiece a little way, and you know why that is done. Now, with our inclined retorts, if we take the gas from the lower end, and as we know that much of the coal would run down there, we also know that any vapors coming from the coal at that point, which might be converted into gas by passing the heated surface of the retort if we take it off at the *upper end*, would go directly into the hydraulic main if we

take off the gas at the lower end, and be deposited there only as very rich tar; and while we could get a good price for the tar, we are not in the tar business, and would rather make gas of it. We thought we would obtain better results per pound of coal by using only about two-thirds of a charge, filling the retorts only part way up, using the upper part of the retort as a superheater or fixer, so to speak; and that is the reason we put the outlet pipe at the upper end.

MR. LANSDEN—I would like to ask Mr. Egner whether he found, in passing the tar up that way, that the condensation took place in the charging neck, the same as it would in a stopped stand-pipe? Would it not have interfered with the flow of the coal freely running down into the retort? I am interested in this matter because I am putting some in myself. This is a new departure, and I want to get all the information that I can.

MR. EGNER—We found no difficulty except from the fact that the chutes were made with a wrong curve, and the coal would drop down into them and lay there. These chutes, for a short distance, have the same angle of inclination as the retort itself, and in charging, the coal would sometimes fill the neck of the chute and lodge there. We overcame that difficulty by taking a sheet of No. 16 iron, and before charging the coal we run that sheet iron down into the back of the mouthpiece, and then dump our coal down between. Any one building an inclined retort bench should not forget to make a steeper curve on the mouthpiece than I have. Another thing to be remembered: In our bench of sevens we have a double curve at the two lower retorts, and that is not a good thing. The coal chute castings should be watched very carefully in the making, so as not to have them rough, and not to make them at all flat, anywhere; because if you do, the coal will lodge there. We had no difficulty or trouble in charging after using that piece of sheet iron; but when we first started we got some of the bottom chutes stopped up, and when we dumped the coal in, the coal laid there and would not slide into the retort, and filled the chute right up to the top. But that was not on account of the tar. That happened the very

first charge that we put in. Necessity being the mother of invention, we got this sheet iron, and it worked very nicely. There is no patent on that, and nobody can get one on it now, as it is free to the world.

MR. LANSDEN—Mr. Egner speaks of the addition which he has made to the system of charging. I wish to say that an English patent which gives that same short chute, which is attached outside (and it would perhaps have the same effect) was brought to my attention in New York by a gentleman who had the patent for sale. It was a plan to do away with that abrupt angle. I do not know whether Mr. Egner has seen it or not. It is patented in England, and they are undertaking to introduce it here.

THE PRESIDENT—That is entirely different from the Coze.

MR. EGNER—In reply to that I will say, I have seen the English patent, and that it was got out by Mr. Trewby, who, as I understood, put the sheet iron into the retort, and charged under it, so as to make the coal lie at any depth he chose to have it lie. He was charging under that sheet, withdrawing it after the charge was deposited in the retort. That is my impression of it, though I may be mistaken.

MR. NORRIS—I would like to ask Mr. Egner the object of contracting the lower ends of this retort. I notice there is a decided depression there.

MR. EGNER—I think that was a very foolish thing to do. We had nothing to do with that. Those were plans furnished to us; and I would not advise anyone to do that, but in building inclined benches to avoid this contraction. It ought not to be there.

MR. NORRIS—How is the coal stopped when it comes down? Does the coal come clear down to the lower part, or do you put in some arrangement to stop it within the furnace walls?

MR. EGNER—We have a shield made of sheet iron, with two arms; and before the retort is charged we put that in. This shield extends just beyond the brick wall. The arms are about 15 inches long and the ends rest against the lower retort lid.

The coal brings up against that. The first lumps of coal strike the shield in charging, and then it fills up evenly to the top or end of the charge. When the coke is removed we open the door, as in ordinary retorts, and the shield is taken out. It is usually found to be a dull red. It is laid on the floor, and then out comes the coke.

MR. NORRIS—I would like to ask the reason which induced Mr. Egner to say that the exterior angle is too flat. Is the difficulty in charging or discharging?

MR. EGNER—The difficulty is in the charging. It is not the retort angle, although the retort might be a little steeper without hurting it any; but the angle, or curve, rather, is too flat in the charging chutes which we have. The cast iron chute at the upper end is the one I mean. That should have the curve of a parabola, not of a circle. When sometimes we just touch the coke it rolls out the whole charge. Our retorts set only at an angle of 29°. It would be better if the angle was about 32°.

MR. NORRIS—In charging is there any difficulty in regard to the coal coming clear to the bottom? In other words, do you get a uniform distribution of coal in your retort?

MR. EGNER—Yes; we have a uniform distribution of coal throughout the retort.

MR. NORRIS—What is the mechanical condition of the coal? Is it very fine, or very clean, or just about enough fine stuff in it to fill up the cracks between the coal?

MR. EGNER—We take the coal at the shed, and allow no lumps larger than a man's fist to go into the hopper. There is a fine and coarse coal altogether; but it all rolls down very nicely, and I have no trouble with it except that spoken of before.

MR. MITCHELL—How does Mr. Egner explain the stopping of the coal in the bend of the chute—what caused that?

MR. EGNER—I think the bend was so slight that before the coal had a chance to roll down, it would bunch up and stop—it would not go any further.

MR. MITCHELL—I understand that the time of the upsetting

of the wagon had something to do with the coal clogging in there—whether it was upset quickly or slowly. Would not that cause the coal to stop at the bend?

MR. EGNER—No. I was going to say further that the castings are very rough; and that as they wear smoother they work better. We tried rolling it down slowly at first, and we thought that would overcome the difficulty, but it did not. When we would throw it down quickly it would shoot down nicely—and that even in the chutes with the double bend—or rather, sometimes it would and sometimes it would not, until we introduced the light sheet iron shield, which we made very steep, then it went down, without bunching up, when carefully dumped, without any trouble.

MR. COGGSHALL—I would like to inquire if the coal at the further end of the incline was as well carbonized as the remaining coal through the retorts.

MR. EGNER—The coal right near the mouthpiece, of course, had some tar with it, and it was not as well carbonized as that which was a little further in. We thought, therefore, to make the shield about 6 inches longer. In fact, before I left I gave orders to have pieces put on to the arms, so as to keep the coal up a little further. It was not as well coked as that further up.

THE PRESIDENT—Shall we hear from Mr. Clark on this subject?

MR. WALTON CLARK—The points that I desired information upon have all been brought out by Mr. Egner's paper, and in the answers to the questions put to him. I am very glad to know the success that Mr. Egner has attained by the use of the inclined system. We all believe in it, and I believe that all gas works will eventually use inclined retorts. There are opportunities there for economizing in labor, and I think also in the fuel used in heating the retorts; and not only in the labor and fuel, but also in the brickwork and in the construction. For in the larger floor area of the retorts there will be very considerable opportunity for economy in first construction, after we have thoroughly mastered the details connected with the building.

The President—Someone has suggested that we would like to hear from Mr. Greenough.

Mr. Greenough—I cannot imagine why such a suggestion could be made, because I do not know anything about the subject. I was about rising to ask Mr. Egner if he could give any figures as to the number of men required to run that retort stack, in order that some comparison might be made as to the amount of labor required to run the retorts in that way as compared with the amount of labor required to run retorts by drawing machines. You have seven benches in a stack?

Mr. Egner—Eight benches of sevens. Before I tell you how many men we employed, I want to say this: You all know that in different sections of the country things are very different as to men. For instance, down in Old Virginia if you make a man work very hard he will throw down the shovel and go to work on the oyster beds; for he would rather work there for $3 per week than in a retort house at $2 per day. In New York, a good many years ago, year in and year out we charged eight benches of sixes with 350 pounds of coal per retort every four hours, and employed six men on each watch to do it. That was heavy work. If we tried to do that in St. Louis every man in the place would walk out. To handle the same amount of coal at St. Louis that we are now handling with the inclined retorts, we would have to have, including the foreman, 17 men on a shift, or 34 men in all; whereas with the inclined retorts we need have only 11 men on a shift. When we started this work we took men who had never been inside of a retort house to work. We picked up green men. We did not want to take the old men, but preferred to take strange men who had not worked in the retort house at all. It did not take long to get them in pretty good training.

Mr. Dell—I would like to ask Mr. Egner what is the maximum charge that he has made so far?

Mr. Egner—The maximum charge is 400 pounds for each four hours.

Mr. Dell—You also said that it took 20 per cent. of the coke made?

MR. EGNER—Yes.

MR. DELL—Was the bench then running at the maximum?

MR. EGNER—No; I think we could have done better than that; and if the men had had more experience, or if *we* had had more experience, we could have done better. It was as well as we could do for the first eight days.

MR. DELL—I have had considerable experience with those furnaces, and I think it will be safe to say when the furnace is in thoroughly good working condition, and when the bench and everything connected with it is in good working order, the proportion of fuel used would be 10 pounds of coke to 100 pounds of coal carbonized.

THE PRESIDENT—That is encouraging.

MR. SOMERVILLE—I think I may preface the question which I am going to put to Mr. Egner by saying we all know the fact that the carbon in our retorts will form into ridges right across the floor of the retort after a certain period. It seems to me that the success of the retort will depend greatly upon having a smooth floor surface, so that the coal will run down without any hindrance. The question that was troubling me was this: If these ridges of carbon were to collect (as they do collect in our horizontal retorts) how would that affect the coal as it is put in? Of course, it would be impossible for it to run over these little ridges as it was running through the new retort. Have you had any experience in that yet? Have you had the device long enough to see if this difficulty was really of importance? I am, of course, certain that the coke would not be able to slide out so easily with the carbon in the retort as it would without the carbon; and, therefore, I think in a year or so we will be better able to judge of the working of these retorts. I would like to ask Mr. Egner if he has seen anything of that before?

MR. EGNER—Yes, sir. You will remember that we have run one bench of 5's in St. Louis for over two years, every day in the year, until May, when we let it down as the furnace was burned out. We relined the furnace, put another coal chute on, and it is running now. If we had not had the experience sug-

gested by Mr. Somerville we would not have put up the additional benches. We would not have gone to that expense if we had not had the two years' experience with the one bench. The retorts are in position there just as good as the day when they were put in. I will say, however, that it happened sometimes when visitors were at those works the men who were taking out the coke would prod away at the charge and take nearly three times as long as when no one was looking at them. They did that in my opinion in order to prejudice people against the inclined retorts. But after running the thing for two years and then starting that old bench up again, we claim to have had enough experience with that one bench to warrant us in building more, and, of course, with eight benches we will know more about it hereafter.

Mr. Boardman—I would anticipate some trouble in scurfing these retorts from the long chute of the lower retorts in the bench, which is made of cast iron, I presume. I would anticipate that you might encounter trouble there in scurfing them, and getting that too hot and cracking the cast iron. I would like to ask if that has been Mr. Egner's experience?

Mr. Egner—No. Of course I have not had charge of the old St. Louis works, except since January last, when the Laclede took hold of them; but I came down every once in a while to look at them. I was interested, and desired to see how the thing was going on. The scurfing was a very simple thing. They would open the upper and lower lids, the air would rush through, and in a few hours the carbon was loose enough to be taken out easily.

Mr. Boardman—I can well understand that you scurf very readily—it is eminently adapted for that; but I should anticipate trouble from that cast iron chute getting too hot. I would ask if that has been the case, or if it could be guarded against by the closing of the lower door? I want to know what experience you have had in that. If those chutes should burn out or crack from excessive heat it would be quite a costly thing to put them back into the interior of the furnace.

Mr. Egner—In the bench that we did run we had one burned

at the mouthpiece, but it was not caused by the scurfing. In the original bench the mouthpiece was filled in all around. When we put the new chute on we put the wall back of it, but did not fill it up solid, and it did not crack again. I should think it was caused by that, and not on account of scurfing. We have scurfed retorts several times since the bench was started, and they are all in good condition except that one.

Mr. Greenough—I think this is a matter of very great interest. If the inclined retort is the best thing that can be used, and if we have got to come to it, we want to know it: and of course we have to watch what Mr. Egner does with a great deal of care. He will know a great deal better what difficulties are experienced after he has run a plant of this kind for a year than he can tell to-day. Do I understand him to say that the 11 men mentioned as running this stack do all the work there is—taking out the coke, and everything else? I want to make comparisons in my own mind as to what can be done with the machinery; and so I would like to know just what those 11 men do.

Mr. Egner—They bring in the coal, quench the coke, and attend to the furnace. One man attends to 8 furnaces. They draw the coke, charge the coal and clean up the house.

Mr. Greenough—Do they run the machinery with which the coal is lifted up?

Mr. Egner—Yes. The coal is brought in in wheelbarrows, and is then delivered by a bucket elevator into the square coal hoppers, and from the hoppers it is slipped into the wagonettes, and from those dumped into the retorts. One of those 11 men is a foreman who watches the whole of the proceedings.

Mr. Greenough—It is possible that if this series of 8 benches that are now put up were 16 instead of 8 there would be a still further economy in the amount of labor required to run them. As the comparison stands at present, with what can be done by machinery, and considering only the question of labor, I am not sure there is any economy. A large gas company can put coal into the retorts and draw it out again quite as economically by machines. We are putting into one stack of retorts as much as

450 pounds of coal every 4 hours, without any difficulty, and working it off. If so large a charge as that can be handled by hand, it may reduce the labor materially if carried on to any extent. Although it would look as though Mr. Coze had been followed up by Cathels (I have never looked at the drawings of Cathels myself, although they were in my office for some time, but nobody had the courage at that time to try the plan) certainly these gentlemen in St. Louis are entitled to very great credit for the success with which they have carried out the scheme; but before we throw up our hats and say that this is what we have all been looking for, let those of us who are engaged in making gas in other ways wait a little while and see how this plan works during the coming year, and then we will be a little more enthusiastic about it than we are to-day; although to-day we are prepared to congratulate these gentlemen on their success, thus far.

MR. A. C. HUMPHREYS—It certainly seems as if gravity ought to be able to do the work better for us than machinery; and, as Mr. Greenough says, it seems as though everything was in favor of the inclined retort, or at least was pointing in that direction. I do not know whether the paper answers the question or not, but I would like to know, if it is not stated in the paper, how long it takes to discharge each retort of the bench. It is the handling of the coke which seems to me to be the chief item of saving of this system. Of course the question of the handling of the coke has to be combined with the question of putting in the coal—because there comes in the angle; but if we have an angle which is proper for handling the coal so as to lay it in the retort evenly, how will it then be as to discharging the coke? What is the result of your experience as to the length of time required for discharging each retort? I was surprised to find at the Southall works, London, England, where the Coze system is in operation in accordance with the modified drawings of the patent which I think has been referred to, that they take a very much longer time to discharge than I had any idea of; for I did not suppose that so much time could be consumed in discharging a retort. To be sure, there is an explanation in stating that these retorts were

20 feet long, and at the works they had already recognized the mistake as to the length.

Mr. Egner—I would say that the average time of discharging the retorts would be about 30 seconds. It has one good effect upon our regular retort house men—they try to discharge the retort quicker than the inclined retorts would let the coke out. I used to tell about a fireman that I had (who has since become a superintendent himself, and has managed gas works for some years)—that he, another fireman and a helper used to draw and charge a set of ten retorts every two hours, with 250 pounds of coal in each, in 8 minutes, and that they did that all day long. They had to charge two scoops of coal into each retort, and they had only one scoop to do it with. I used to tell our men that, and try to get them to "hustle," as we say out West; but they would not "hustle." Now that we have the inclined retorts they *do* try to get the coke out of the horizontal quicker than the men can get it out of the inclined retorts; but they cannot do it. They can draw a horizontal retort in less than a minute, but the "inclined" men can take it out in less time than that. I would state from observing it, as I have done very carefully, that it takes about 30 seconds to draw an inclined retort. Some come out quicker, and with some it takes longer; but there is not over 8 seconds difference.

Mr. Russell—I would like to ask whether it is 8 seconds per retort or 8 seconds per bench?

Mr. Egner—Eight seconds per retort.

Mr. A. C. Humphreys—While the conditions at the London works I have referred to might have been a little unfavorable on the day that I saw the exhibition made, I will say it took from 4 to 4½ minutes to discharge each retort. The trouble about it was the length of the retort; and I think they recognized that trouble. I call attention to that point so that those who are working the inclined retorts had better think a long time before they put in any of such lengths.

Mr. Egner—I would say to Mr. Greenough that we are not yet committed to the inclined retorts. We are doing pretty

well with them, but we are not irrevocably committed to using only inclined retorts. We are looking at charging and drawing machines also, and at water gas apparatus as well.

On motion of Mr. Humphreys the thanks of the Association were voted to Mr. Egner.

Mr. Edward G. Pratt, of Des Moines, Iowa, then read his paper on—

THE EXTENSION OF THE USES OF GAS FOR PURPOSES OTHER THAN ILLUMINATION.

The subject indicates, at once, that I am expected to enter that field of thought to which most of us have had our minds directed during the past 2 or 3 years, and which, it seems to me, is bound to occupy more and more of our attention during the same period of time now before us. "Gas for fuel" touches the popular chord, and more especially in localities where a large proportion of the fuel used is bituminous coal, and where, as a consequence, the inhabitants are suffering from the resultant smoke and dirt. To such, the question of convenience seems to be of only secondary consideration, as with each recurring period when necessity demands the kindling of fires, and each chimney represents a miniature volcano, then does the supplication go forth, "Oh, if we only could obtain some other fuel than this miserable soft coal."

Is it sympathy with this suffering people that the same chord is set vibrating within our own breasts? I think not, else some means would have been devised long ago, whereby a suitable substitute would have been procured. It is true we have done our best to keep up the supply of a substitute in the shape of coke, and at prices fluctuating with those of anthracite coal, so that as far as expense to the consumer is concerned, it has been nearly as great and quite as troublesome.

To those living in more favored localities, as pertains to the subject of fuel, these unpleasant experiences cannot be fully appreciated; hence the fuel problem, to them, is simply a matter of convenience. In this age of progress, however, the two words necessity and convenience have become nearly assimilated

and what seems applicable to one is fitting to the other. What, then, has been the motive that has caused us to energetically push our business in a direction, that, until the past few years, received but little of our attention and encouragement?

Formerly we were satisfied, seemingly, in doing that business that came to us, without making any special efforts, or offering inducements that would attract attention, for our business was that of furnishing gas for light; and that we discouraged its use for any other purpose is true, as the oft repeated question to a consumer who had reason to believe his bill was excessive, " Do you use a stove in your house," clearly indicated that any device, aside from the ordinary burner that consumed gas, we were in doubt about, and was not sanctioned by us, inasmuch as the too excessive gas bill was attributed to its use. Now, how different, being on the alert always, any gas-consuming device that we can consistently recommend for a purpose meets with our approval, because it fills a want and helps increase our gas sales account.

In my endeavor to answer this question, these thoughts naturally suggest themselves:

While gas companies of the large towns and cities throughout this country report large increases in their sales each year, may it not be attributed more to the increased demand for gas for domestic and mechanical purposes, contingent upon reduced rates, than to any other reason? Is it a fact that we have been stimulated to seek other methods of disposing of our product on account of the demands made and the success attained by electricity? And, somewhat contrary to the law governing such things, by which the demand precedes the supply, are we not to a great extent indebted to the numerous manufacturers of gas appliances for the energy and skill displayed in the devices they now aid us with?

Granting these, our duty lies clearly in keeping up with the possibilities as they appear before us, for we have reached a period now where the growth of our business depends upon constant vigilance; indeed, it is about as necessary that we create a demand as that we supply it.

At the works under my charge we have made special efforts during the past season to create an impression upon the minds

of the public favorable to the use of gas for fuel purposes, that is, to an extent consistent with its economical use; and, while we are aware that there are others who have made greater progress in this direction than ourselves, we are satisfied with having done better than was anticipated. And, while it is true that we have worked energetically, we have been very cautious about recommending only that which merited our approval, realizing that one defective or inferior appliance would do us more harm than 50 perfect ones would do us good. For this reason, as much as for any other, we have been opposed to the rental system. Stoves kept in stock for rental purposes naturally become old stoves, and perhaps have been turned into this stock because they were unfit to sell, hence, in my opinion, they are unfit to use.

We do, however, approve of payment by the rental system: that is, a sufficient charge for rental is made to secure the payment of the stove in full within, say, six months. By this method you reach a class who otherwise could not afford to purchase outright. We secure a consumer, and good care of the stove is assured, and there is less liability of its working being condemned.

Previous to this year, we labored under the disadvantage of not having sufficient space to show off a stock of stoves, having depended entirely upon the few samples displayed in our office, and from which sales were made.

This was very unsatisfactory, for, aside from the fact that it required the attention of a clerk from his regular work, and who, perhaps, was unable to talk stove or gas for fuel, the idea of having to wait until we could order from the sample selected, oftentimes precluded an opportunity for sale; and, judging from the dispatch with which some manufacturers have failed to fill orders this season, it is very fortunate we laid in a stock early, as the desire would have languished by the time the stove was received. Influenced, therefore, by what others of good judgment have done, we rented a storeroom on a prominent corner, and stocked it with as many stoves, both cookers and heaters, as space would permit, not forgetting to arrange them in as attractive a manner as was possible, making also a display in the windows.

The different types and sizes of stoves and other gas appliances were connected up ready to show at any time. Then we employed a man, competent to make practical demonstration of what could be done with a stove—in other words he could cook, with instructions not to allow a customer to escape through any doubt as to whether this thing or that could be done satisfactorily with a gas stove. Then we advertised—we advertised in everything that would advertise us—and it is wounderful the number of advertising mediums there are, and the friends you have, when once you have expressed a disposition to advertise.

The fact that we had gas appliances to sell, however, was not of so much importance as that, for gas used for fuel purposes, we made a special rate of $1.50 per M., the former price, and also, that for illuminating purposes being $2 per M. The stoves were sold at about 10 per cent. advance over the manufacturers' prices, and we set them up at no expense to the purchaser. These three things—reduced price of gas, stoves at cost, and no contingent expense for setting up—have done more to assist our enterprise than anything else. It has not only resulted in getting many of our regular patrons for light to use stoves, but has attracted the attention of many who had not thought of using gas for light even, to place a stove in their homes; skeptical though they were at first, some of our best references now come from this class.

Realizing, too, that we had a powerful competitor in the vapor and oil stoves, we have lost no opportunity of displacing these whenever such opportunity presented itself, and have made liberal allowances for such in exchange, knowing full well that a gas stove once set was a consumer gained. And because a gas stove had been recommended to them as being an expensive luxury, finding it otherwise, we have in these our strongest advocates.

To lend interest to what already had been done, we, very early in the season, engaged the services of a young lady, well up in the art, to give a series of cooking lessons, using, of course, a gas stove in the preparation of the food. It is unnecessary to say that this was a very taking feature; and being quite inexpensive, inasmuch as an admission was charged to

give tone to the affair, which paid the expenses, resulted in very much good to us; for, besides creating an interest in behalf of the gas stove for those who had never used one, the fact was clearly demonstrated to others who had, that there were many things possible in their operation that they had no previous knowledge of.

These practical illustrations demonstrated the fact that a gas stove is not only a summer stove, but is invaluable for winter use as well, where cooking is reduced to a science by means of quick regulation and easy operation; and we have several instances now in mind where arrangements for warming the kitchen in winter by the furnace have been made, the intention being to perform the family cooking with a gas stove throughout the year. Hence, while it has been previously supposed that about all the stoves we could dispose of must be during three of the summer months—and to a great extent it has been true—I believe it to be a good policy to keep them before the people in such a way that they will have cause to know there are many things for which they can be used and concerning which we are familiar. Heating stoves are looked upon with favor, especially for intermittent work, and we are very careful in explaining to what extent a gas heating stove may be economical. They are, as is well known, convenient things, and will be largely used when the price of gas will admit.

The same thing would partially apply to the gas engine, though from experience I can say little in regard to them, as we have none in operation in our city, the two there having long since been displaced by electric motors. It seems to me, however, that the first cost of a good gas engine precludes their more general use for one thing; then, again, the manufacturers of the various types of electric motors have canvassed every town and city in the country where they could obtain current for the sale of their goods. Might not something be accomplished if the gas engine manufacturers displayed the same enterprise?

There is no doubt but with gas at $1 or $1.25 per 1,000 a gas engine of from one-horse power to 10-horse power could be operated quite as cheaply as the prevailing charge for elec-

tric current, and certainly more satisfactory, for it could be depended upon, which cannot be said of the electric motor.

Of course, very much depends upon location, as to the cost of making steam, and the consequent success of a gas engine; but it seems to me that with some assistance from the manufacturers, and an effort on our own part to make a rate for gas, consistent with their operation being made economical, there is an opportunity for the gas engine, such as it has never yet had. Having had but little practical experience with a gas engine, I am not posted as to their efficiency, though I have received statements from superintendents of gas companies operating electric light stations, which would indicate that other fuel must be very cheap to compete with them, at the cost they charge themselves up with for gas. If this be true, and I have no reason to doubt it, then I believe that gas companies operating electric lighting stations should, where possible, in making future improvements, adopt the gas engine. If we have any confidence in the gas engine and expect to have it in more general use we must, at least, use it ourselves, and the manufacturer of engines, together with the manufacturer of stoves, must give us the best possible apparatus for the least possible money, so that the average purchaser can afford to buy.

Since May 1st of this year, when our special rate went into effect, we made a practice of setting a separate meter for each consumer where gas was used to any extent for fuel purposes; the question of estimating gas for such purposes being unsatisfactory, necessitating an argument with each settlement, in which the consumer usually affirmed that there had been very little gas used for light.

The question here arises whether it is good business policy to make differential rates favoring that used for fuel, especially if it becomes necessary by so doing to set a separate meter where there is one already set; to which I would say, yes, unless it be that there isn't enough difference between rates for light and that for fuel to warrant it; and then I would be tempted to say, make another reduction in your fuel rate.

Upon this subject I have been very much interested in reading an article in the *American Gas Light Journal* of January 28,

1889, and I think I cannot do better than quote one paragraph therefrom: "The recommendation of such measures (referring to differential rates) by the slow acting but ever studious authorities of the German government plainly shows that they, at least pay no heed to the thought that has made so strong an impression on the policy of some American gas companies —the idea that special rates may prejudice them in the regard of the consumer in general; and the statistics given must cause an extension of this verdict to the German gas companies in general, the proprietors whereof are content in the knowledge that a wise system of discriminative rates has neither involved them with their consumers as a class, nor interfered with their receipt of a legitimate profit. Indeed, quite to the contrary in the latter regard. A public clamor in regard to the shrinking of gas rates in any department of supply to the lowest possible figure is not to be feared—at least where the maximum rate is a reasonable one; and it would seem to be, to say the least, supersensitiveness to entertain such a belief in localities that have considered the public interest in consulting their own."

In our city of 52,000 people, with the gas consumption averaging nearly 5,000,000 cubic feet per month, our gas sales have, during the eight months of 1890, increased 22.18 per cent. over a corresponding period of time in 1889; 70 per cent. of which increase I attribute to fuel purposes, made possible by a reduction in the price of 50 cents per 1,000.

I estimate that of all gas sold, the percentage for fuel purposes for five months previous to September 1, was about as follows: April, 7 per cent.; May, 10 per cent.; June, 14 per cent.; July, 17 per cent.; August, 16 per cent.

During that period we sold 121 stoves of different sizes, receiving therefor $1,945.42. The net value of all stoves, etc., on hand September 1, over that of April 1, was $916.83.

Our total expenditures for everything incident to gas appliances, during the same period of time, amounts to $3,520.79.

Deducting value of stoves on hand September 1, as above ($916.83), leaves our net expenses at $2,603.96, being in excess of receipts for stoves, etc., $658.54. The profit derived from the gas consumed in these stoves during the period covered by

the account (five months) was in excess of the loss shown on the stove account, and the stoves continue to use gas at the regular price. Our Company believes the investment to be a good one and that it will be returned to us many fold.

Incidental to this we have been obliged to lay two miles of mains, brought about through the interest created in gas for fuel, in a district remote from the center of distribution, and previously covered by the electric light. We expect to secure liberal patronage, not only in the use of gas for fuel, but for light as well. I might mention that we supply the electric light, but that makes no difference, for we had just as soon relieve ourselves of an electric light patron as we would a competitor.

Already I have had numerous inquiries made as to the feasibility of heating residences by gas, and hardly a day passes but that I am besieged by some enthusiast who "believes he has an idea" that he can heat his house economically by gas during the approaching winter, and seems really disappointed when informed that at this time, and the present price, we would not care to make the attempt, knowing full well what the result would be.

"All things are possible," however, and we hail the day when it will be our privilege to conscientiously proclaim "Eureka."

Discussion.

THE PRESIDENT—Gentlemen, you have listened to a paper which interests every member of the Association. It is a paper which should receive your careful consideration and discussion.

MR. BUTTERWORTH—The subject gives rise to a very discouraging and hopeless reflection on the part of a great many gas companies located in towns in Pennsylvania, Ohio, and Indiana, where they have natural gas. The question of interest to gas companies there is not so much how to extend the use of gas for purposes other than illumination, but is rather how shall we be able even to hold the consumption we have for illumination, as against natural gas. Heretofore, and previous to the introduction of natural gas in Columbus, we sold gas stoves at cost, and did everything we could—changing gasoline stoves for gas stoves, and sold gas at $1 per thousand feet. Now we

would be very thankful if we could get back the old consumption that we had for illumination. We cannot hope to compete with natural gas at 10 cents per thousand and artificial gas at $1 per thousand for purposes other than illumination.

Mr. A. C. Humphreys—I would like to suggest one hopeful thought to Mr. Butterworth, which is that perhaps the natural gas regions are the most favored in this regard, for they will have their people there so educated on the gas question that they will never want to abandon the use of gas. If they will just hang on by the teeth until natural gas goes out, they will have a chance when illuminating gas again comes in. One point in Mr. Pratt's paper ought to receive very careful attention at the hands of our members. I refer to these words: "If we have any confidence in the gas engine, and expect to have it in more general use, we must at least use it ourselves, and the manufacturer of engines must give us the best possible apparatus for the least possible money, so that the average purchaser can afford to buy." I think we have a perfect right to look to the gas appliances manufacturers to do even better for us than they have done in the past. Although Mr. Pratt in his paper has given them great credit for their work in the past, I feel that, especially in the line of gas stoves, we have a right to expect more; that we have a right to expect better stoves at lower prices. I prophesy that if the gas appliances men do not give them to us, we will get them for ourselves. It is coming, as sure as can be. And the same thing is true with regard to gas engines. If the gas engine men will not give us the proper gas engine, we will get it outside of their help; and even if we have to wait until the patents expire, we will have it then. I do not think, though, that the patent question will interfere. We have a few good gas engines, but I am free to say I do not think the gas engine interest in this country has been handled with the slightest degree of liberality. I refer especially to the one engine which has made the greatest advance. I think we have every right to expect better and more liberal treatment from the gas appliances men. If other questions in connection with our business had been handled in the same way that those questions have been, I do not know where the gas business would now be.

Mr. Taber—I would throw in a compliment to our gas men because I think Mr. Pratt has rather underrated the percentage of gas sold for gas stoves in the summer time. I remember that in our Guild in Boston we had a comparison of figures as to the amount sold for lighting and cooking purposes by New England companies during the summer, and I think I am not wrong in saying that the average came nearer 25 or 30 per cent. of the daily consumption than what I take it to be here in this paper—16 or 17 per cent. It was certainly very high. Perhaps the reason is to be found in the fact, from some figures that I tried to get awhile ago, I have reason to believe that the gas companies have been instrumental in getting out more than 10-000 gas stoves in New England within the last three or four years. I think we ought to encourage ourselves in that matter, and not alone in respect to cooking stoves, either. Some three or four years ago a gentleman who was connected with our Company told me very gravely he thought we would not get out any more gas stoves; but since then we have got out 500 gas stoves. So I do not think that many of us know to what extent this will develop. In the heating stove, as in the cooking stove, there is great room for advance. Last winter I had occasion to heat a block that had previously been heated by ordinary coal stoves. I put 14 gas stoves into that block and succeeded perfectly. I had no difficulty whatever. I throw that out as a suggestion to many of you. It seems to me that we generally think the gas stove season is over when the birds go South; but I think that the money part of it comes just when they go; for there is more money (if we do not tell the public of it) in gas heating stoves than there is in cooking stoves. As to this matter of special and differential rates I may say we had quite a question over that, and I want to say a word about how we did in New Bedford. Our regular price at that time was $2, with 10 per cent off. In order to facilitate the introduction of gas stoves we made a special rate to anyone who would use over a certain amount of gas every month—say about 4,000 feet. We counted the house lighting and the fuel gas together, and if a party used over about 4,000 feet per month, we put the price at $1.50. In that way we avoided the necessity for an extra meter (which Mr. Pratt put in), and accomplished our object very sat-

isfactorily. I think there is a great future ahead of us; and I am glad to see that during the past summer so many novelties and so many conveniences have been added to the gas stoves which have been lately developed. I am very glad to re-echo the remark which has been made, that the best gas stoves are going to be very much cheaper than we have had them heretofore.

MR. BOARDMAN—Mr. Pratt calls attention to the employment of the gas engine by those gas companies which are engaged in electric lighting. Having occasion to go into electric lighting, I took the opportunity to look into the matter of substituting the gas engine for the steam engine, under the conditions there existing, and, considering the size, the demands upon them, and the cost of fuel and the cost of gas in the holder, I found that for 100-horse power the cost for fuel to a gas engine running 12 hours was $13.50 as against $8.25 for coal to be used under the boilers to generate the same power. Allowing for the labor additional in the case of coal, and it leaves about $3 per day (or night) against the gas engine. The first cost of the gas engine to get that power was a little in excess of the cost of the boiler and engine using steam.

THE PRESIDENT—Will you also give us the price of coal per ton, and the price of gas per 1,000 feet?

MR. BOARDMAN—At that time my gas was costing me 45 cents per 1,000 feet, and the cost of coal was $2.75 per ton. I am figuring on the large consumption of coal which was necessary at that time when I was using high speed engines. More economy can be obtained in the coal than that, but I do not think that much more economy can be obtained in the gas engines than I have stated. Another thing that deterred me was it would take about 20 per cent. of all the gas that I could at that time supply to furnish the gas engine; which would force me to have a bench in operation when I only had use for one-half of the gas that it ought to make. I did not think the economies to be derived, or the advantages in setting a good example, were quite sufficient at that time to induce me to get the gas engine. I merely state this as a piece of information which you may think over.

MR. TABER—I will supplement that piece of information by saying that in one of our New England stations the Superintendent and I went carefully over the figures together, and we found that in the gas engine the horse power was developed with gas equivalent to about three pounds of coal. That is, we could supply the gas at the cost of three pounds of coal per horse power.

MR. A. C. HUMPHREYS—What we are speaking of is the consumption of gas per horse power per hour; and I would ask Mr. Boardman whether he has taken into consideration the fact that the cost of his gas is not any longer 45 cents per 1,000 if he has added 20 per cent. to his output.

MR. BOARDMAN—I was figuring on the gas consumption, which was about 25 feet per horse power per hour. I did not take into consideration the fact that the cost of my gas would be reduced by increasing the output; but I found that the decrease in the cost of gas by reason of increased output would be to some extent lessened on account of my not being able to use the full bench for that purpose.

MR. DIXON—I beg to say that it seems to me that for large engines, say 25-horse power, gas cannot compete with coal; but that for small powers it is away ahead, and that it is also away ahead of the electric motor. I know that in looking up the figures for the cost of small powers in New York, I found that electric motors could be furnished by electric companies in New York at the rate of $1 per day, and that a gas engine would require for the same power, at the cost of gas in New York, 75 cents per day. There is a saving of 25 cents. If the gas engine builders would be as liberal in furnishing their motor as the electric companies are now furnishing the electric motors the difference would be still more apparent. But for such small powers it is now considered cheaper in New York to hire the motor and the power all in one lump.

MR. COGGSHALL—If gas engine builders had put the same amount of work into disposing of their goods that the electric light manufacturers do with their apparatus there would be no difficulty in gas companies having something to do with the

gas engine. There is not a town or a city where there is an electric light station but what you find men canvassing for motors. A great deal of that is done. Take, for instance, the oil stove. You cannot go through our city, or through any other city, and pick up a newspaper but you will find an advocacy of certain kinds of oil stoves. Who pays for it? The oil stove manufacturers, to my certain knowledge. But, for anything else than an oil stove, as for instance a gas stove, if we advertise that, we have to do it at our own expense. If the manufacturers would join with the gas companies the business could be increased to a large extent.

MR. SCRIVER—It seems to me the question of the price of gas stoves lies entirely in our own hands, for we can manufacture them ourselves and furnish them to our consumers at the very lowest cost, and a good deal cheaper than by buying them from manufacturers and selling them at a profit. That is one reason why gas stoves are not more extensively used. In my city we have paid special attention to this branch of industry. We sell our gas and have, from the beginning of the introduction of gas stoves, at a very much lower rate than for ordinary purposes. We put our gas down to $1 per 1,000. We considered that it was a wise step and that it is a wise policy. We have increased our manufacture of gas to a very great extent by the introduction of gas stoves. We have sold and put out a great many gas stoves for the reason that we have been able to manufacture our stoves ourselves, and sell them at a very small profit. It is a surprise to me, when we consider that there is a very large business with gas engines, that the gas companies have not taken hold of the gas engine industry and worked it with greater vigor, but I can easily understand why a gas company should have let alone most of the gas engines on account of the extreme price. Manufacturers of gas engines will not make a gas engine and sell it unless they can get about the same profit proportionately that the manufacturers of sewing machines or pianos do, which we know is very excessive. I will give you one comparative instance only of gas *vs.* coal as fuel. We have a large number of gas engines out in Montreal, but in one particular case a 7-horse power gas engine has been running, in a printing establishment, for the

last 7 or 8 years, at a cost of about 80 cents per day, for 10 hours' running. Previous to that they had a little steam engine and boiler in their printing room, which caused a great deal of inconvenience in summer on account of the heat, and a great deal of inconvenience at all seasons of the year on account of the dust that it created. They introduced the gas engine, and they are very much pleased with the result in every way. The cost, as I have said, is about 80 cents per day for the gas engine, while the steam engine cost them about $1.20 per day—showing a difference of at least 40 cents per day in favor of the gas engine. I believe if we were all to work up the gas engine trade as well as the gas stoves we would find our output of gas materially increasing from year to year. I believe that there is another point we ought to take hold of. I have not yet seen a gas burner that was adapted to heating water in our boilers for heating our houses. Not a Fall that comes when I do not have a large number of persons who ask us, "Can we not heat our houses with gas? Can you not invent a burner that we could use in our boilers for heating our water?" A large number of our houses in Montreal are heated by hot water and steam—the greater proportion of them; and when the time has arrived that we can have a perfect burner for heating the water in our boilers, then I think we can all exclaim, in the last word of this paper, "Eureka!"

MR. LITTLEHALES—I would like to ask the last speaker if he can give us an idea what his stoves cost when manufactured by his company. I may say that we in Hamilton experienced the same difficulty that others have referred to with reference to the cost of stoves. We found that after paying import duties, in order to sell the stoves at a very small profit, the consumer would have to pay $20 or $30. Now, those stoves are being made at a cost of $17. We are selling them at $17, cash, or we rent them at $4 per year, and after the fifth year they become the purchaser's own. The cost for a four-hole stove, about the size of a No. 8 stove, is $17. I would like to inquire how the cost of Mr. Scriver's stoves compares with that.

MR. SCRIVER—Such a stove as Mr. Littlehales speaks of we could not sell in Montreal at all. They are too cheap.

Mr. Littlehales—I will say that the stove that we are selling at $17 is as good a stove as any that Mr. Scriver has in his place.

Mr. Scriver—We sell and put up in consumers' houses a stove similar to the Goodwin No. 8 or No. 8 A, with four holes on top, extension wings, and all the latest improvements, cast iron front and top, and nicely nickle plated, including all the fittings to the stove from the service pipe, and including an extra meter, with the fittings and stopcock complete, for $30.

The President—I have been compelled during the past summer to concede the fact that there are two sides to the question of cheap stoves. That has been something of a hobby with me for some years at Columbus—selling stoves at cost, or at manufacturers' prices, and setting them up for nothing. The plan was so successful there that I got to believe that that was the only way I could make the stove trade successful. After going to St. Louis, the time for the stove trade came around, and the question was raised as to how they should be handled. There was a very considerable opposition to the idea of the gas company handling stoves at all. We finally agreed to set up without charge the stoves of any company that would sell their stoves at manufacturers' prices. We were able to get one concern who agreed to do that—they having nothing to do with the stove except to keep it in their warehouse and sell it. Our man would go to the warehouse, get the stove, and set it without charge. A manufacturer of stoves in the city did not think that there was any money in that sort of business for him, and so he wanted us to set his stoves for nothing, and let him sell at a profit of 40 per cent. above the manufacturers' charge. We would not agree to do that unless he would sell more than 350 stoves. If he sold less than that during the summer he was to pay us $350 for setting his stoves up; and if he sold more than that we would make no charge for setting those stoves. As I said, there was another good stove there which was offered at manufacturers' prices. I think that over 1,300 stoves have been set in St. Louis during the past summer; and even now, this late in the season, they are being set at the rate of 50 or 75 per month. I venture to say that 80 per cent. of them were stoves of the man who had

W. A. Stedman.

the 40 per cent. profit. He established about 50 stations in the city for the sale of his stoves. He would put a stove in the house of everyone who would sell a stove or handle them at all. He had 50 solicitors throughout the city, and he pushed his work for all that there was in it; and he has made a great deal of money, and we have sold lots of gas.

MR. McDONALD—I would like to ask Mr. Scriver where they set the meters that are used in connection with gas stoves?

MR. SCRIVER—We set them as close to the service pipe as we can get them.

On motion of Mr. McIlhenny, a vote of thanks was tendered to Mr. Pratt.

Mr. Robert M. Dixon, of New York city, read his paper on

THE PINTSCH SYSTEM.

An account of the Pintsch gas system involves a description of the apparatus (invented by the late Julius Pintsch of Berlin, Germany,) which has made the use of compressed oil gas a practical, economical, and satisfactory method of railroad car illumination. The use of oil gas for lighting cars, boats, floating buoys, etc., possesses distinct advantages over the use of a gas of lower candle power. Oil gas can practically be made of about 75 candle power, and this, after subjection to the losses due a compression, to say 200 pounds per square inch, will still be from 60 to 65 candles, while 19 candle gas, after the same treatment, will not be more than 10 or 11 candles. The use of compressed coal gas has been tried on a large scale, and under the most favorable conditions, both in Europe and America, and has been decidedly unsatisfactory. The receivers, for carrrying the gas under the cars, have to be of greater size, and the charging stations must be more frequent, and equipped with expensive compressing and storage apparatus of large capacity, some six times as much coal gas as oil gas being required for a given amount of light. The cost, also, is in favor of oil gas. This can be made and delivered to cars, according to the Pintsch method, at a total cost of less than $2 a 1,000.

City gas at $1.25 a 1,000 will cost put in cars, $2.35 a 1,000, and six times as much is required, making the relative costs as about 1 is to 8.

For manufacturing the gas and compressing it for delivery to the receivers under the cars, requires a plant consisting of a gas works, naturally of small dimensions, which may be located at any available place, and pipe lines connecting them with the car yards and stations. For the pipe lines three-fourths X strong iron pipe is used, and if the length be great, and quick charging of cars is desired, an accumulator, from which the gas is drawn for the cars, is placed at the yard. In laying the lines no provision is needed for draining or drips. All moisture and vapors are effectively removed during the process of compression.

The gas works themselves comprise furnaces for the production of the gas, some small condensing apparatus, a plate washer, purifiers, a station meter and gasholder, together with compressors and large store holders, into which the gas is forced and held ready for delivery through the pipe lines to the cars. Each furnace consists of a setting of two retorts, one arranged above the other. At one end of the furnace, a double mouthpiece connects the ends of the two retorts. The oil is fed into the other end of upper retort, and the outlet pipe for the gas is taken from the end of the lower retort just below.

The retorts are heated by a fire below them, separated from the lower retort by a fire-brick wall. The products of combustion pass along the sides of the lower retorts, heating them to the proper temperature for gas making, and passing into the chimney along the sides of the upper ones, heating them also, but to a less degree, by the heat which would otherwise be wasted.

The cleanliness of the retorts is found to have considerable influence, not only upon the amount of fuel used, but also upon the yield of gas from a given quantity of oil. In order that they may be easily cleaned, each end of each retort is provided with a cover, and an iron pan is used in the upper, into which the oil falls, serving to prevent its coming into direct contact

with the hot retort, and facilitating the removal of non-volatile elements contained in the oil.

The lesser heat of the upper retort vaporizes the oil, and in this condition it passes to the lower retort, the greater heat of which serves to bring it to the condition of a fixed gas. The gas passes to the water seals located below the level of the retorts, and in the conveying pipe is placed a try-cock for determining the quality of the gas that is being made. The amount of oil fed into the retorts is based upon the indications from the gas at the try-cock, and more or less supplied to accord with the temperature. After the gas is condensed, washed, and purified, it is metered and reaches the gasholder. The compressors are driven by steam and are especially constructed for the purpose intended. The gas is received by them from the gasholder, compressed, and forced into large storage cylinders ready for delivery to the cars.

The oil required for 1,000 cubic feet of gas made in these furnaces, is from 13 to 16 gallons of crude petroleum or naphtha. Our men prefer to use Pennsylvania crude petroleum, and the amount of coal required in the furnace for producing this 1,000 cubic feet is about 100 pounds, of course depending upon the quality. For compressing the same amount, about 80 pounds of coal is required in the boiler for making steam.

Gas is carried on cars in receivers suspended underneath the framing of the floor. For cars with a total of 150 candles light, and not more than two nights service away from the charging plant, one receiver, about 9 feet long and 20 inches diameter is used, containing under 150 pounds pressure, which is our standard, about 200 feet of gas which is sufficient. For cars having a greater amount of light, and in service on trips which carry them away from the charging plant more than two nights, additional receivers are used. Frequently 2 or 3, and sometimes a total of 4 receivers are used on each car.

On each side of the car is arranged a valve for attaching a gas supply hose, and this valve is connected by pipes to the receivers. It requires from 2 to 5 minutes to supply a car, or if more than one car is to be supplied at once, 5 or 6 can be supplied in as many minutes, provided they are all connected by hose to the gas distributing pipe lines at the same time.

In order that high pressure on the gas receivers may be reduced to the small one needed for the burners, and the latter be constantly maintained, a regulator is used. The Pintsch regulator will absolutely and automatically control all pressures from 1,500 pounds per square inch down to one-half pound per square inch, and maintain a constant pressure of about 1.4 inches of water at its outlet, no matter whether 1 or 100 burners are lighted, or whether all are shut off. The regulator is placed underneath the car, near the outlet of the gas receivers, so that all gas under high pressure is kept outside of the car and away from the ends, so that in case of accident they are not liable to be broken.

The principle upon which the regulator works is that of an equilibrium of forces. The high pressure from the receivers passes through a very small orifice at the inlet of the regulator, which orifice is closed more or less by a valve, held against it by a system of levers and links. The latter to connect with a leather diaphragm of 50 inches area, and a variation of from 1 pound to 500 pounds at the inlet cannot appreciably affect the outlet pressure. The leather of this regulator is especially prepared to withstand the destructive action of gas on such membranes, and experience has demonstrated the thoroughness of this treatment. Many thousands of them are already in use, and it has never failed except from abuse or the breaking of the cast iron case enclosing it.

From the outlet of the regulator the gas is carried along by a ½ inch pipe to some convenient place under the car, where a pipe leads it to the top of the roof. At some available point in the pipe leading up through the car is placed a main controlling cock, by which the flames of all the lamps can be regulated. The pipe passes along on top of the roof of the car, which branches off to each of the lamps or burners in the car. The gas supply to each lamp is also controlled by a cock.

The satisfactory illumination of a passenger car requires a sufficient amount of light so distributed as to give an even, brilliant light the entire length of the car. A lamp of high candle power is not used, and if used would not be satisfactory. A sufficient number of lamps should be placed in a car to enable reading with perfect ease at any part of it, and to do this

properly it is necessary to have the lamps not more than a certain distance apart. If spaced too widely apart then the shadows at the point between the lamps is so great as to be inconvenient, and lamps of not extraordinary power are therefore more efficient in lighting.

If the attempt is made to light with lamps of very high candle power, then in order that the proper amount of light may be had at the points of minimum lighting, other parts of the cars will be over lighted and over heated, and the amount of gas burned and consequent expense of lighting will not increase directly as the amount of over lighting, but according to the rule of squares. It has, therefore, not been the aim of the Pintsch system to use lamps of very high candle power, those ranging from 40 to 60 having been found sufficient. In fact, those of 40 candle power have been found the most satisfactory in even illumination.

The Pintsch lamps consist of the main body of the lamp suspended from the roof of the car either by a center column or by outside suspending arms. From a body is suspended a transparent bowl, which, with a white reflector extending entirely across the top of the bowl, with the exception of an annular space which serves as the entrance to the chimney, forms a chamber in which the gas is burned in fishtail flames. From two to six burners are used in a lamp, depending upon the light required at the location of the lamp in the car.

The upper part of the lamp consists of a glass crown or dome. The lower end of the flue or chimney of the lamp consists of a mica chimney, the upper end of regenerative passages. The light which escapes up the flue is reflected out through the mica chimney and the glass crown of the lamp, producing a pleasing and effective illumination of the ceiling of the car. The products of combustion pass up through the flues of the regenerative portion of the chimney, and the air for combustion is taken in near the top of the lamp and the top of this flue, and passing down outside of the mica chimney and between the reflector and a deflecting diaphragm, is highly heated before entering into the combustion chamber of the lamp. The effect of this absolutely shadowless and draught-proof

lamp in car lighting is most pleasing, and produces a most brilliant and efficient light.

The Pintsch system is already applied to over 36,000 railway carriages, and is rapidly being adopted by the railroad systems of America. Gas works for the supply of cars are now in operation or course of construction at Boston, Stonington, Conn., New York, Jersey City (4), Syracuse, Marion, O., Chicago, Cincinnati, St. Louis, Denver, Ogden and Atlanta, and over 1,200 cars are lighted by this system in the United States.

Discussion.

THE CHAIRMAN—You have listened to a very interesting paper. Will Mr. A. C. Humphreys lead off, and tell us how to make it profitable and practicable to the gas companies?

MR. A. C. HUMPHREYS—I suppose that the only way in which the established gas companies of the United States can make a profit of this business is by co-operating with the Pintsch system—perhaps by operating their plants, which I understand companies are now doing at some points. I think it is a good idea. It is unquestionably the fact that we of the regular line are not equipped for this business. And still, I think we should not consider this an outside business; but we should be willing to encourage anything in any line that will take hold of and spread the gas business where we are not properly equipped for that particular work. I therefore think that Mr. Dixon is eminently one of us, and that his system should be encouraged by us. It is not perhaps amiss to note that the system as we have it in this country is by very long odds superior to what it is in the country of its birth, or even in the other countries around it. While we have to thank the Pintsch father and sons for the admirable way in which they have worked up the details of construction of their apparatus, they did not find it necessary to provide for very brilliant illumination in cars. It seemed to them wasteful to light a car as is done in this country by the Pintsch system. They cannot understand why it is necessary for us to use lamps with more than a single flame. There they depend, or have in the past depended to a great extent, upon travelers having their own

pocket lamps. But we know that that will not do in this country. In England, also, it is not the habit to provide illumination in the cars to the same extent as is done here. It is only fair to say that great credit for what has been done here in the development of the practically efficient lamp now used by the Pintsch system is due to Mr. Dixon. I think it would be well to forestall criticism on Mr. Dixon's part for him to say that in comparing the cost he is comparing the bought gas with the manufactured gas. But that is a small matter, as it is unquestionably very much cheaper to light a car by means of compressed high candle power gas than it is by low candle power gas. We know that by experience in our own line. We are compressing at some of our stations ordinary city gas, but the cost to the consumer will not compare favorably for this purpose with the cost of lighting by the Pintsch system. I think that the point made by Mr. Dixon with regard to the way that the lamps should be distributed in the car cannot be questioned for a moment, for, especially in car lighting, we must secure a uniform distribution of light. I think if any gentleman here has occasion to examine a car lighted by this system in this country, he will find that he can sit and read in any of the seats of the car, and if he can for the moment forget where the lamps are placed, I doubt if he by the effect on his page can tell where the lamps are located. That may seem to be a strong statement, but I think that observation will verify what I say. I do not want to close without saying a word about the Pintsch regulator. I suppose that the credit for this instrument is entirely due to the Pintsch family. I do not know that any changes have been made in this country. I think it is about as near perfection as anything that we can use. Some of the stories that I have told about the regulation of gas by the Pintsch regulator are such that I am afraid that some of my friends are almost willing to doubt my veracity; but I know that it has done work for me that I could not in advance have believed to be possible.

THE CHAIRMAN—Mr. McMillin will please add a few words.

MR. MCMILLIN—I do not think that I will carry on the discussion further than to make this remark: The question might

arise in the minds of many gas people here, "Why do large gas companies care to bother with the little Pintsch system in works for lighting a few cars?" That is the question which would naturally be suggested by those who have not fully considered the matter. I do not know whether there is any profit in the business; and although the figures presented show a very handsome profit, I am unable to accept them in good faith. But, whether there is a profit or not, I feel that it is absolutely dangerous to permit anybody but a gas company to have even a small gas works in your city. You do not want any other man to start works in a little place where he can make even a few hundred feet per day, because the demand for the gas will keep growing and growing, and he extends his works, and after a while you will have a competitor. It was to prevent anything of that kind, more than it was for the sake of the money that was in it, that induced me to undertake it in St. Louis. I am frank to say, however, that I believe it will be as profitable as any other branch of our business.

MR. DIXON—Mr. Humphreys and I had no arrangement of "you tickle me and I will tickle you," but I want to say that I owe it to Mr. Humphreys in being started in the right direction in this system; and that it was he who did more than anyone else to bring the system up to what was demanded by American railroad companies.

MR. BOARDMAN—Before giving up my position in Macon I had been working to put in a small Pintsch works there for the purpose of lighting the cars on the Central Railroad system and other railways centering in that place. It occurred to me that not only could it be useful in this particular way, but that it might be used to advantage as an educator and feeder for my regular gas plant. To my mind, in all cities, and especially here in the South where the cities are growing rapidly, a large portion of new territory is being built upon by the better class of people who desire to get away from the noise and dust of the busy streets with which we are troubled in this climate, but who, being beyond the reach of our mains, and likely so to be for a number of years, and until the district which they gradually people has been built up sufficiently to pay the cost of

running a main there, are practically without gas unless they introduce oil gas systems, or "greased air" systems. I accordingly thought it might pay to educate these people, to get them to put gas pipes, chandeliers, and fixtures in their houses, and thus become gas consumers finally, by furnishing them the Pintsch gas, by delivering it to them in wagons, weekly or monthly, in smaller cylinders than are employed by the power companies. Then when the time shall arrive when we can afford to lay mains in that section we shall secure them permanently as educated gas consumers.

MR. SOMERVILLE—If you go to a railroad company for this business, and say that you will light their cars as cheaply with gas, and that you will give them a much better light than they are now paying for oil, they naturally expect that it would be profitable for gas companies to do it at that rate.

On motion of Mr. McMillin a vote of thanks was tendered to Mr. Dixon for his paper.

The Association then adjourned to Thursday, Oct. 16, at 9.30 A. M.

SECOND DAY—MORNING SESSION.

The Association was called to order at 9.30 A. M., President McMillin in the chair.

The President opened the proceedings by reading the following telegram:

"*To the President of the American Gas Light Association:*—Charles Hunt, of Birmingham, England, sends from Birmingham, Alabama, greeting to his American brethren assembled at Savannah, and heartily wishes them a successful and enjoyable meeting." (Applause.)

Mr. F. H. Shelton, of Philadelphia, read his paper entitled

THE GAS ENGINEER AND HIS PENCIL.

Mr. President and Members of the American Gas Light Association—Gentlemen:—To take a slight liberty with an old proverb

(by omitting one letter), the successful gas engineer may be said to be a veritable "Jack-of-all-trades and master of *one*." For most of us recognize that the modern gas man must have at least a smattering of knowledge of many callings besides his own, and that to successfully keep the public satisfied and his stockholders happy he must at various times act as lawyer or lobbyist, diplomatist or politician, financier or economist, mechanic or engineer, chemist or electrician, architect or draughtsman, as the case may be; and, in short, have knowledge of a thousand and one points beside his direct craft of how to deliver gas at the burner at the lowest possible figure.

In selecting the subject that I have I wish to call to your attention the importance, from a gas standpoint, of one of the vocations above of which the versatile gas manager is supposed to have some knowledge, and which I think is but too often unappreciated and neglected. I refer to the gas man as a draughtsman, and in offering the suggestions that I shall, I desire to say that they are chiefly for those who may, perchance, be unfamiliar with the subject from lack of a technical education, and for those who, from having a works too small to support a regular draughtsman, find that whatever work of this nature is to be done must be done by themselves.

If one but stops to think of this subject it is almost self-evident how desirable and important the ability to use the pencil is to a gas man, whether managing but an oil gas plant or the largest works of a metropolis, for the economic and satisfactory carrying on of his work. Plans of works and of buildings; drawings of firebrick work, of apparatus or connections; maps of street mains, etc., are often to be made, and all bespeak the importance of knowing how to clearly depict the same. The knack of sketching or quickly setting forth one's ideas by a few lines is of almost daily use, and whether one is chalking the outline of some shape of iron on a blacksmith's floor, or is sketching on the back of an envelope an odd connection to one's foreman, he wishes to succeed in conveying the idea and to be more successful than the traveler in a restaurant abroad, who, desiring to have some mushrooms, and unable to speak the language, made a sketch of one. The waiter, apparently comprehending, rushed off and returned with *an open umbrella*.

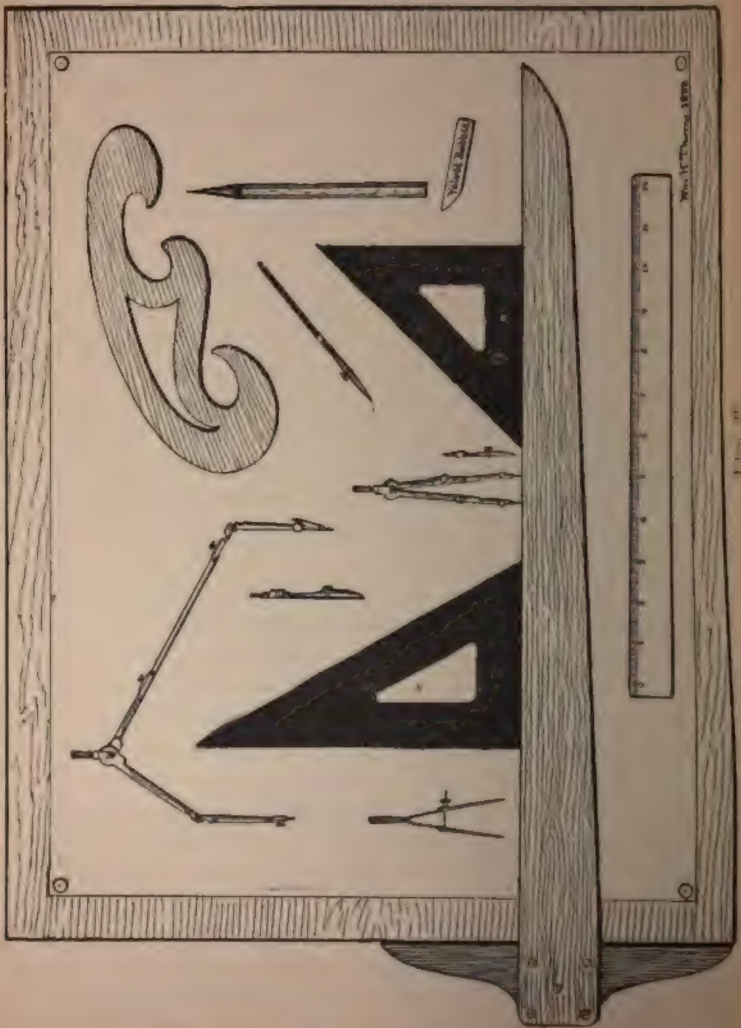
Very many gas men do almost nothing in the way of draughting, and very many works are lamentably lacking in plans and records that should most undoubtedly be on file. I believe that if more attention were paid to this detail of the business the effort would be well repaid, and it is my hope to show in this paper, in calling your attention to the subject, that the matter is not such a bugbear as some may imagine—that the skill of a professional and accomplished draughtsman is not required, nor a costly lot of instruments, but that a moderate degree of skill, with some little care and system and a few standard instruments, will be all-sufficient to enable one to properly make and keep the "pencil records," so to speak, that I think ought to be kept, and which I shall point out.

Regarding instruments: A drawing board, or broad, flat-topped and firm table, a T-square, one or two triangles, a scale, a dozen thumb-tacks, a moderate-sized pair of compasses, with pen and pencil attachments, and a ruling pen are really all the essential implements required. I advise, however, on account of their great convenience, the having, in addition to the above, of a small pair of spring dividers, a scale, an "irregular curve," and a larger pair of compasses with extension leg for large curves and circles. The following cut (Fig. 36) shows such an outfit complete.

The drawing board or table is best, of course, with trued and squared edges and sides, from which to work the T-square in any direction. If unable to secure such, however, true and vertical lines at right angles with the horizontal can be readily made by working with the T-square from the left hand edge only, and using the triangles along the edge of the square, as shown in Fig. 36.

Paper of any style preferred and liquid India and colored inks can now be bought at almost any stationery store, while pencils and rubber erasers one usually already has. Five dollars to ten dollars will cover such an outfit, excepting the table. Of course, any amount of money can be spent for a greater variety of instruments, for greater convenience, or for special work; but precisely as Benjamin West painted his first great picture with a brush made from the tail of the household cat, and as some of the finest specimens in taxidermy have been

prepared in the forest on the tailboard of a wagon, so will you find that while costly paraphernalia is certainly convenient, yet it is not *necessary*, and that the great bulk of the work in draughting can be done with the tools mentioned above.



There are three general directions in which I think the pen-

cil of the gas engineer should be exercised in a well managed company, viz, "The works," "In Distribution," and "At the Office."

The Works.—One of the most fitting things, and one that is at the same time both useful and ornamental, that can be hung in the gas office, is a well drawn and neatly framed "property plan" of the gas works. Many may doubtless say that they "know every inch of the works," and do not need such. Possibly. But I venture to say that if, to prove this belief, you attempt to draw even a general plan of the works, and put in the data from memory, you will find that you do *not* know a great deal that you think you do, and will soon be looking up the facts; and if you do make such a plan you will be surprised at the number of times that you will use it, and will not willingly relinquish it. When cogitating upon changes, at the works, such a plan helps wonderfully; and whether demonstrating to the ubiquitous insurance man that your works are more safe from fire than Gibraltar, or to the tax collector that there is really nothing at all worth assessing at the works, or whether you are in correspondence with some constructing firm to which you wish to send a plan of building or works, or are simply talking with your foreman regarding changes in apparatus or connections, you will find it equally useful and convenient, and saving many trips to the works.

Such a plan should be pre-eminently an accurate record of the chief data of construction and arrangement of the works, and to lay out and make such I herewith offer the following suggestions as to method that may be followed and points that should be embodied:

First, get the exact property lines from the original deeds, which should be in the archives of the company in the safe. Then, for curiosity's sake largely, take an accurate tape line (steel or wire woven preferred) and a small boy to hold the end of it, a pad and a pencil, and a half day's time, and check off the property lines by actual measurement, noting how nearly correctly located or not your fences may be. If the lines do not agree, the city engineer or surveyor should be called in to verify the facts. Remember that, in certain States at least, the law is such that if part of your land has been unused by you

for 20 years, it is liable to claim by your neighbor, if during that time he has had the use of it, without protest (unless, of course, by permission), and is disposed to so trouble you. Then, with the tape line, take the exact location and measurements of all buildings; the size inside of all rooms; the location of all doors, windows, stairways and pilasters; the depth of cellars; the height to eaves; the location of all apparatus and connections, and of every valve, and of all joints accessible. Locate your gates, driveways, water service (and stop-cock in same), sewers and drain pipes, oil pipe line from railroad and railroad switch, if adjacent. In short, secure everything by measurement that you can think of and constantly take several measurements from different points to the same object, in order to "tie in" and check your work. You can hardly get too much; and the more complete the finished plan, the greater will be your satisfaction. When ready to make the drawing, determine upon the scale. Do not have your sheet too small, but of such size that the data and notes and drawing proper can all be put on without an appearance of crowding. For a small works, a scale of 8 to 12 feet to the inch, on a sheet perhaps 36 by 24 inches is a good size. For larger works, of course the sheet must be enlarged in proportion, until, if necessary, it is 4 to 6 feet square. I have noted very admirable property plans of this approximate size in the offices of the Boston, Montreal, St. Louis, and other companies.

In making the drawing and transferring the data to the sheet take time and ensure accuracy, and thus avoid the soiled effect that follows if you have to erase ink. You will be surprised as you go along, at the number of little changes and corrections that you will make, and as you cannot erase ink satisfactorily, have everything *right*, in pencil, before touching ink. When inking in, put in all underground pipes, etc., in dotted lines, and indicate the depth of such, when known, by numerous little figures such as this, $\frac{}{5}$ (the figure under the horizontal line indicating *the depth beneath the surface*, of the pipe at the point in question). Put in all the rest of the work in full, clear lines, and the walls of brick or stone buildings in solid black if you so please. Or, if you are good at coloring, the walls may be painted, after inking in, with a light wash of red or gray, ac-

cording as they are of brick or stone. The main gas pipes may be colored in the same way, an iron gray, the drain pipes a terra cotta or light brown, and, if in great detail, the steam pipes blue, the water pipes green, and the oil pipes red. The apparatus proper may be then shaded and colored according to the respective part, and the grass portion of the works given a wash of very light green. Such a plan as this can, of course, be elaborated indefinitely almost, according to the skill of the artist. When neatly done everything stands out in good relief, and all the connections, etc., may be traced with great ease. When all is completed put on your notes, in neat lettering, with pen and ink.

This whole work is primarily a record for reference, and I believe that in addition to the usual general measurements, the following and all such kindred memoranda should appear, viz., the size inside of all rooms; the distance in the clear in gates and driveways; the distance between buildings in the clear; the names of streets or railroads, or of rivers or other water, and of property owners adjoining; whether the water service is city or private; ditto, regarding sewer; railroad switch—whether owned by the gas or the railroad company; if switch is elevated, height of rails above coal shed floor; capacity in tons of coal shed; diameter and height of each holder or holder lift, and working capacity of same; pressure cupped and uncupped; diameter and depth of holder tanks; diameter, depth and capacity of oil, water, and ammonia tanks; harbor line; depth of water off dock at high and low tide; height of dock still above water at mean tide; names and makers' names of each part of the gas apparatus, year installed, and capacity of same; horse power of engines and boilers, and speed required on blower for given pressure, etc. I presume some of you will think that I am unnecessarily particular in recommending such detail (and I grant that the gas manager is supposed to carry the greater part of this in his memory), but it is just such points as these that are constantly, for the moment, being forgotten. At such a time a glance at a plan, as outlined above, may save a trip to the gas works to get the information desired, or much vexatious delay.

I am sure, also, that should any unexpected change of administration occur, the incoming superintendent would be very

grateful to his predecessor for such information so well recorded.

In finishing up the plan put in an arrow to indicate the points of the compass, and a title in clear lettering. Frame and hang by wire, not by cord. Rust will not affect it, and moths will not corrupt it and cause all to come down with a crash, as I have known to occur.

I give herewith a cut (Fig. 37,) which shows the general appearance of such a plan as I have in mind. Owing, however, to the small scale upon which it must necessarily here be drawn, I have been compelled to leave off very many measurements and memoranda which should appear upon an actual full-sized plan.

A plan as above, I believe, should be on record in every gas office. It should be supplemented by like property plans of any outlying holders or other property of the gas company, and any elevations of holder houses or buildings or photographic views add to its completeness.

In addition, plans and drawings of all apparatus at the works should be kept safely at the office, for reference in case of repairs, relinings, alterations, etc. Such plans of the detail of plant and apparatus the gas manager is usually not called upon to make himself, but can get from the constructors of the parts in question at the time of erection. In this latter case, see that the drawings as secured are corrected in accordance with the many little changes almost sure to have been made in course of erection.

Distribution.—Whatever may be said *pro* or *con* about the importance of the foregoing, there can be no question about the necessity of full and complete records of street mains.

How many of us are dependent upon our foreman for this most important knowledge; and how many of us would be caught if such foreman should unexpectedly strike, leave us, be taken ill, or die? I hold that there should be in every gas office complete records of every foot of main and of every special; of every service, lamp post, drip and valve, so that in case of the defection of the street man for any reason, the superintendent has the knowledge on record with which to instruct his succesor.

The whole subject of street main records is an exhaustive one, and I can here refer only to the portion in which the pencil of the gas engineer comes into play.

The foundation of such records is a large, complete, and correct map of the city or territory supplied. Such a map can nearly always be found or else made by enlarging a small one. If this latter is necessary, perhaps the easiest way for the gas man to do it is by the system of squares. In this method the smaller map is ruled off into small squares, and each one of these is then readily transferred by copying on to the larger sheet on the scale desired. On the large map every foot of street main should be indicated, in the proper streets. These mains may be shown by lines of one color with figures written over them to denote the size of pipe, or they may be put in with various colored inks and combinations of dots and dashes for the different sizes. In this latter case a key to the colors should be put in one corner. The latter is much the more preferable way, and I am disposed to recommend the following plan as one of the best for carrying out the detail. The leading feature of the plan, is to show to the eye by a glance, when familiar with and by a careful selection of colors, the general size of the mains in any district.

For instance—we start from the gas works with some dark colored line (as purple or blue) to indicate our largest main. As the main gets smaller the line is broken by dots and dashes, giving a lighter effect to the eye, and indicative of the next smaller size pipe. After say three sizes of pipe have been so indicated by different combinations of dot and dash, but all of the same color, a lighter color is used in the same manner for the next three smaller sizes and so on down, until the lightest color attainable (yellow) indicates the smallest, or 3 and 2 inch main. For 1¼-inch, and 1½-inch "main" so-called, or for large service pipes I prefer to write the size in small figures right in the colored line rather than multiply colors. A main system so depicted shows very clearly to the eye, by the gradual lightening of the colors, the decrease in the size of pipes as one gets away from the gas works and can usually be indicated by the use of but 3 or 4 colored inks.

The Office.—I wish to call to your attention a direc wherein a pencil of the gas man may come into play at office; draughting, which while perhaps not as important as preceding work indicated, yet, to my mind, is of great int and well worth the doing. That is, the graphical plotting charts of the figures of output, leakage, or other data monthly and yearly record, reference, and comparison.

There is nothing like a cold fact in black and white, stantly before one's eyes, to spur one on to renewed efforts, I think that plotted charts of what we may be doing, ser distinct and useful purpose in that way. If, for instance such a chart, the line indicating the percentage of leakage sh take a sudden rise, it must be an eyesore to the conscien superintendent until he can restore it to its normal position; if the line indicating the output for a just closing year sh not the usual growth over that for the preceding year, it constant reminder and incentive for him to watch more clo every means by which he may increase his consumption.

To make a graphical chart of this nature is not difficult. a large sheet of paper, lay off a base line, say 24 inches lo At intervals of two inches erect perpendicular lines, say inches high. Then across these lines and parallel with the b line draw a series of lines, say a quarter or a half an inch ap Your sheet is then ruled both ways. The vertical columns r resent months, the horizontal divisions thousands or millions cubic feet of gas output, according to the size of your compa and should be so marked. A convenient paper for this purp is what is known as engineer's paper," which can be bought ready ruled in both directions in fine blue lines one-tenth of inch apart. As many of these lines can be taken as needed, a given space desired, and heavier ones ruled in to suit th works or data in consideration.

It will be readily seen that if your output for January is 10 000,000 and a mark be put in the tenth horizontal line in th column for January, and if your output for February be 8,000 000, and a mark be put in the eighth horizontal line in the co umn for February, and so on throughout the 12 months, and line be drawn through and connecting all these 12 points, su a line will represent very clearly the fluctuations of one's ou

put for the year. The succeding year's output should be put on the same sheet in the same way; and it will be seen that if the output is increasing, and is, say, a 1,000,000 feet or so larger for each month than the preceding year, the second year's output will be proportionately higher up on the sheet, and opportunity for most direct comparison given. If the annual outputs do not vary much, and the lines cross and recross, colored inks should be used for the various lines in order to preserve clearness. The lines for a series of years so plotted make most interesting and instructive data, and show very clearly the progress of the company. When abrupt changes in the output occur and the line has noticeable fluctuations in it, the reason should be stated in a foot note. For example—"Potomac Mills closed for two months;" "eighty-two lamp posts disconnected this month," or, "gas stove business entered upon, this date," etc., etc.

This plotting of the output by months as above is usually the chief feature of the sheet. Additional spaces, however, should be ruled off into appropriate size for the plotting of the yearly outputs, and especially for the plotting of the monthly percentage of leakage. The direct showing of this latter item I consider as perhaps the most important matter on the sheet. There is no getting away from it, and its tendency, from its "silent action" on the superintendent's mind, toward the reduction of the leakage account is most beneficial. Plotting may, of course, be carried out to a much greater extent if desired. The percentage of annual increase of output; the daily, the weekly, or quarterly outputs; the number of meters in use; the number of gas stoves; the yield per pound; all such figures may be graphically delineated at the fancy of the superintendent, if so disposed. It is also well to have a column at one side of the sheet, in which to keep a record of monthly station meter readings, and another in which to note the estimated annual population of the city. I give herewith a cut (Fig. 38) showing a few samples of such plotting.

In framing, the sheet should be so arranged that it can be readily removed, in order to make the monthly continuations of the lines or other entries.

If well planned at the start, such a chart may be made to

cover a period of 10 years or more; and if well kept up it not only furnishes constant food for reflection, as it may be studied, but becomes, in a degree, a visible history of the progress of the company. I believe it to be well worth the keeping.

In closing, I wish to disclaim more than a very moderate amount of knowledge of the subject of which I have written, and to apologize to those to whom I have, perhaps, said nothing new, knowing that all of that which I have recommended is practiced in some companies, while to others much of what I have said will not apply. At the same time there *are* some companies which would be bettered were the pencil of the gas engineer used more freely—bettered in themselves from having the benefit of and the satisfaction of complete records, and in the eyes of others from the fact that if work in this direction is seen to be thorough, it argues thoroughness throughout.

To the managers of such companies I would emphasize once more the desirability of keeping all possible pencil records. Even if you feel, perchance, that exact and elaborate drawings are beyond your ability or the time you can give to this work, then make free hand sketches. Such rough drawings are far better than none at all, and in some cases are even better than an elaborated drawing to scale, as they permit of the enlarging and bringing out the more clearly of certain prominent points, or a central idea, if so desired. Free hand sketches, however, when not drawn to scale should have the measurements all the more fully and more clearly marked upon them.

To those of you who desire a good and simple treatise upon draughting I would recommend a series of papers entitled "Lessons in Mechanical Drawing," that appeared in the *Scientific American Supplement*, in 1876 and 1877, by Prof. Charles W. MacCord, of Stevens Institute, Hoboken, N. J., (since issued in book form by Munn & Company, N. Y.) and to a series of three hand-books entitled "Junior, Intermediate and Senior courses in Mechanical Drawing," by Wm. H. Thorne, M. E., Director of the Drawing School of the Franklin Institute, Philadelphia, Pa., 1890. (Williams, Brown & Earle, Chestnut and 10th streets, Philadelphia.)

If in any of you I have awakened the draughting conscience, or to anyone been of service by suggestion, I am well pleased.

Discussion.

The President—You have heard read a very interesting, and, to my mind, a very profitable paper, that I trust will be thoroughly and expeditiously discussed. Mr. Shelton is ready to answer any questions that may be asked him.

Mr. Egner—Only a few days ago I had a little example of how much memory is worth and how true Mr. Shelton's remarks are in the matter of how beneficial it would be to put designs down on paper. Coming along on the train a friend said to me, "Mr. Egner, can you draw the face of your watch?" I said, "Yes, no doubt I can." My friend remarked that it seemed to be not very much of a thing to do, but that there was a good lesson attached to it. I took out pencil and paper and drew the face of my watch—I thought I could not make any mistake in that, as I saw the face of my watch many times every day—so I drew the face of my watch, correctly, as I thought. In fact, I thought I had made a very nice sketch of it. I handed it over for inspection, and was then asked to show my watch, when, to my surprise, I found that it was as unlike the drawing as could be. *This* part (the chain ring) was not where it ought to be at all, for I drew it *there* (about half-way to the right of its proper position), and even the figures were wrong. How much more can we be mistaken in our more complicated gas works, even though we see them every day. We think we know just where every valve, pipe or drip is, but the time may come when we will find that we are mistaken. Therefore, I think the suggestion of Mr. Shelton, that we should have sketches of everything about the gas works, is a very good one, and has been done, no doubt, by most gas engineers in the past.

Mr. Mooney—I agree with all that Mr. Shelton says about having plans and maps, and I would have the office plastered with them; but I think they need not be made by the engineer of the works. He has other things to do. He is paid a high salary, so the company could not afford to have him spend his time making plans. He is compensated for doing other things. Again, I don't think you can teach these bald-headed men by

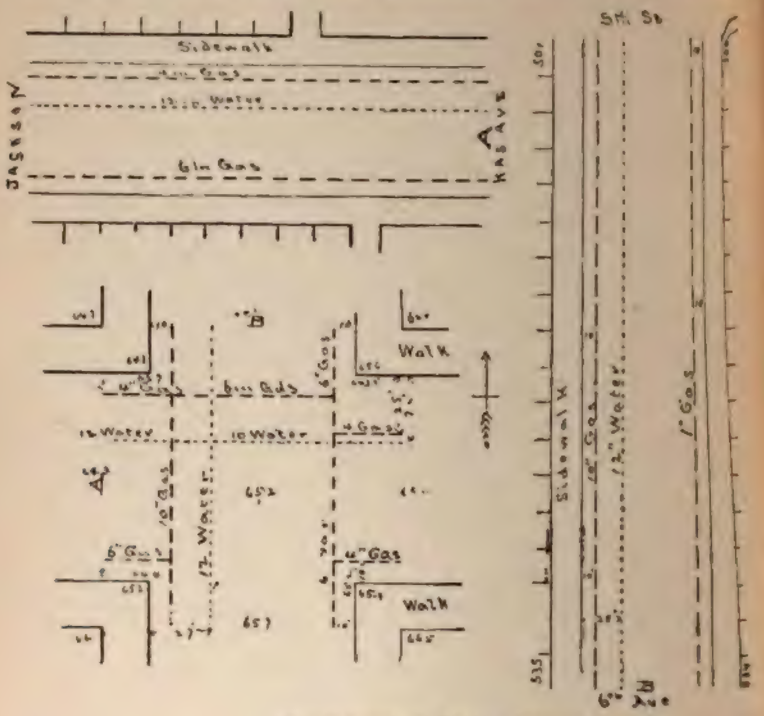
getting drawing boards and getting them to go to work and take lessons. They will not do it. They have no time for it. It is a thing that has to be learned from youth. I think the engineer has too much work to do now, and he cannot afford to go to work and learn how to draw plans.

Mr. A. C. Humphreys—I would like to reply to Mr. Mooney. I think it would be a very sad thing, after hearing that excellent paper read, for anyone to go away with the impression that he cannot do the work that Mr. Shelton has mapped out. As Mr. Shelton says, if you have not the time to devote to the study, so as to be able to make a regular mechanical drawing, you can do the same work by free hand sketches. There is not a man in this room, who, after studying for three months in the evenings, cannot do practically everything that Mr. Shelton asks for in that paper. I say that without any reservation at all. It is not necessary that he should make a finished drawing. He simply wants to record the facts. One of the most important things in that paper is the pointing out of the fact that it is not necessary to make these drawings to scale; but if a man cannot do any better, he can have systematic order about it, and can have things in such shape that he can get at his facts, and he can easily learn to show them in free hand drawings, on an enlarged scale, in one direction, or have no scale at all, but simply show what he wants, and put the figures in, and he has got his facts. If we are all going to be draughtsmen like some of the engineers of our body, then we must make provision for a proper course of study, and follow this plan up. I confess that I would not want to start in now to make a finished drawing, for my hand is "out," and the work would be slow, and the young men in my office can do it better and quicker; but still I would be able to go to work and make the original record sketches, and do it rapidly; and I think there are very few men in this room who have less facility than I have in this direction. I sincerely hope that the members will not be discouraged from attempting to follow Mr. Shelton's advice.

Mr. Chollar—The paper of Mr. Shelton pleases me in a very high degree; and many of the points made in it are those

which I have been trying to solve for many years. I agree with the gentleman who has just preceded me in thinking that there are very few engaged in the gas business, who are willing to devote an hour or so a day to a systematic record of their works, but will find that in the course of a year or so they have accomplished great things. There are one or two points in the paper with regard to keeping of the record that personally I have found not to work well. One is in recording the lines in colors. Most people might succeed very well in it, but I have found myself unable to follow out the plan. I know I am partially color blind—and many people are so who do not know it—and I find that colors are not as reliable as characteristic dotted lines and marks. Another point is this: It is necessary to have two maps, one on a small scale—a bird's eye view—and another on a larger scale for giving detail. I have worked at this latter a great deal, and do not know yet if I have got the thing right. We find a necessity of keeping the record on a large scale in such a way that it will not duplicate any part of the pipe system. I will make a little sketch (see diagram) on the blackboard to illustrate what I mean. In making a sectional plat of a pipe system, it is a little difficult to get it so that on any two sheets you will not have some part of the system on both. If you have any part on two maps, it leads to confusion. I have a plan which I have at last adopted, and it economizes space a good deal. For instance, here is a street intersection. Now, suppose that we have a main going down this way, another one going that way. If we make a general map in sections we are liable to get some part of the pipes on two or more sheets. My system is to stop right at the line (property line) here, and here, and here. This part of the plat takes in only the intersection of the streets, and is for convenience put at one corner of the sheet. That part goes across the block from one property line to the other. This is the street crossing the other one, I put it here at right angles with the first. We do not put down the inside of the block at all, but simply the street. This gives plenty of room for dividing off for lot lines, and it is not possible to duplicate any part of the mains on any of the maps, and by reason of leaving out the inside of the blocks, you have plenty of room for putting

in memoranda about the surface, etc., and can use up the paper to the best advantage. I have finally come down to this plan, and would like to have the gentlemen criticise it. I would



The figures at Street Corners are grade elevations.

like to say that on the street corners of the large scale plat, I put the elevations of the curb stones, the corners of the blocks, and also the elevation of the pipe lines and the water pipes.

Mr. A. C. Humphreys—I would like to ask now, after having had it explained by Mr. Chollar, if any man in the room cannot get up and make that sketch.

Mr. Egner—I think that anybody in the room can do it as well as Mr. Chollar. (Laughter.)

Mr. Chollar—I see that I have made a mistake, and have shown one of the pipe lines on the wrong side of the street. I

do not think that Mr. Egner could make a sketch like it. He is always so busy that he can't find the time.

MR. M. S. GREENOUGH—I agree with Mr. Humphreys that it is not wise to let the impression go out that this matter of putting our data on paper in the way suggested by Mr. Shelton is something so difficult that we cannot all do it. Mr. Shelton has taken all the maps which he has seen in our office in Boston, and I am quite sure that he has been examining our archives as well as what he has seen upon the wall; because I think that we have on paper practically everything that he has suggested, with the possible exception of one of the diagrams. I think that a diagram at the gas works, showing the make of gas by weeks, rather than by the month, is a still more instructive diagram than that of Mr. Humphreys. We also have diagrams showing the increase or decrease in the labor account per 1,000 feet of gas made; and also the cost of handling the coal, and other things which perhaps are not necessary in small works, but which are interesting as showing just what is being done. The only criticism that I would make would be this: I think it is very doubtful whether it is worth while to put on to any map anything except the gas pipes; and I also question to some extent the use of the various colors. That is a thing that we have been trying, and I have vainly endeavored to accustom myself to it. Our old maps were always made with the gas pipes colored red, and I find it very difficult to look at a map which is colored red, brown, yellow and green and to keep in my mind that any of those pipes are gas pipes except as indicated by the red color. It is at any rate much better, if quite a number of different colors are put on a map, that there should be no pipes on it of any kind except for gas. I have in my office a map showing the whole territory of our city, with all the suburbs, on which no pipes appear which are less than 12 inches diameter, and that is the map which I find I use a great deal more than any of the others. I find that the detailed maps which are in the Assistant Engineer's office, and which contain all these different colors, and showing the gas pipes, water pipes and sewers, so confuse me that it is very difficult to use them as readily as I can the old-fashioned map, on which there is nothing except the gas pipes, and they are in red. It is quite easy to make a

map in which there shall be a number of dots showing the sizes of pipes until you get up to 18 or 24 inches; and you can read such maps just as readily and as quickly as you can any combination of color. I take no other exception to the paper, and I think it is an admirable thing to carry out so far as we have time to do it.

Mr. Adams—I think, perhaps, no one has greater cause to know the great difficulty in keeping records, particularly with regard to the classification and the earlier processes of gas making, than I have; and I think that if there could be a general move in the direction of keeping records of comparative yields, and particularly of the yields of residuals under certain conditions (which are now becoming a great factor in the question of gas making) it would be one of the best things that could possibly be done by this Association; and if these results could be compiled, brought here and exposed at the meetings, I am certain it would be productive of great good. I heartily second Mr. Shelton's appeal for more systematic and exhaustive records of the work done by the various gas companies in the United States.

Mr. Harbison—I want to state a personal experience of the value of just such maps as Mr. Shelton has suggested in his paper, to emphasize if possible, what he has said on this subject. I thought years ago that I had a pretty familiar knowledge of the Hartford gas works, and of their property. Four years ago or so I undertook the work of laying a larger distributing main or feeder across the city, and to do the thing properly I began at the fountain head—at the gas works. I thought I knew where every pipe underground was located, and about its depth below the surface. But it took me several weeks, with a large gang of men, before I could get outside the yard into the street, in order to get the system in the gas works as it should be and as I wanted it—simply and only because my knowledge of the matter in my memory was at fault. The pipes had originally been laid by the former manager. They were laid at every angle, and at every conceivable depth. To-day I would not have any difficulty in finding any of the pipes in the gas works, and not much difficulty in finding any in the streets of

the city, because I have carefully prepared maps. Quite a number of years ago it was my pleasure to visit the office of the Providence Gas Company, and there to interview my friend Mr. Slater who is an encyclopædia in gas matters himself; and the statistics of his office are as complete as they can be. In his office I saw such a chart with regard to output as Mr. Shelton alludes to in his paper, and when I returned home I deputized the duplicating of that work to one of the young men in the office, and we have kept it up ever since. I should regret exceedingly if that chart were destroyed. I also set him at work (because he then had some leisure) in making a map of our street mains and I find that it is of exceedingly great value. I thought I knew just where every street main in Hartford was located; but we have so added to our pipes, the water company have added to their pipes, and the sewer pipes have been so multiplied, that without the assistance of the chart we could not tell just where our pipes are. I have kept a record of them all on our books, and it is of exceeding great value. The cost of doing it will be ten times repaid, even if you have to employ an engineer or draughtsman to do it for you. In five years every man in this room would save more than the time and expense required for making such a map, even if he has to go outside and hire the work done by a draughtsman. I have felt repaid the cost many times by the annoyance which has been saved me personally in managing our business, in being able, in the street or in the office, to instruct the foreman just what to do, and in being able to know myself where things are, and to make my plans accordingly. I would advise with regard to the street mains map, that your foreman, and you yourself, should have it in mind continually, and every time you see the surface of the ground broken for any street connection, by anybody, or any excavations whatever made, to get the measurements to your own pipes, and to verify those measurements, and also verify the positions of the water pipes and of the sewer pipes; so that whenever you have to put in any new pipe you will know just what grade to make it in order to make it work successfully. There is not a suggestion in Mr. Shelton's paper which is not of practical value to every man in this room, and to every man connected with our business, whether he is here or absent. I think

it is one of the most valuable papers that we have had before us for many years; and when the proper time comes I am ready to raise both hands for a vote of thanks to Mr. Shelton.

Mr. Ramsdell—I have been using that system for keeping the records of the amount of gas sold, etc., and I have found it practicable. I think in works where there is not a very large increase, and the lines intercross each other so much, it is a good plan to take a trial balance paper, which has 12 columns, and put the names of the respective months at the heads of the columns, with the years at the side, taking one sheet for each of these items that you wish for comparison, and then, by simply filling in the figures each month, you have the whole thing on one sheet for as many years as you want it; and you have it perfectly plain. Take any month, and, by looking right down the column, you can see just exactly how the gas in that time has fluctuated, either in the amount of gas sold or in the output. I have found this to work better in my own case than using a diagram.

Mr. Harbison—May I say a word further, on another thought that occurs to me? It is not to be expected that any gentleman in writing a paper for the Association, of a practical nature, of this kind, can outline the details of a plan which will suit every works. What is wanted for the city of St. Louis, with its large business, would not perhaps be just as practical in all its details for the city of Hartford; and what would be advantageous for us in Hartford would not be just the thing for some other works not as large as ours. But when you get the general idea, every man can then work it out and keep his details according to his own requirements as will be best for him. It is a general idea that I think Mr. Shelton wants to impress upon you—to get us all started in the right direction, if we have not already commenced; and then every man can work out the details to suit his own convenience, his own wants, and his own requirements.

Mr. John Young—In the natural gas business it is somewhat of a difficult matter to keep a record of the manufacture of the gas. The works are so situated that they are not very easily got at, but in distributing the gas we have to exercise considerable vigilance and care. The gas being carried at

a comparatively high pressure—a much higher pressure than illuminating gas is—we have consequently to exercise more care in the case of leakage, and the gas having no odor makes it still more dangerous. The plan that I have pursued with regard to the pipe laying has been this: My foreman keeps a record of every day's work. If he is laying a piece of pipe he notes the depth at which it is placed, the distance from the curb stone, the location of the valve, of the joint, of the branches—exactly where they are situated—and at the end of the month he sends me in a report of all the work that has been done during the month, for every day in detail. That report is given to the typewriter, printed, and put on a file; so that we could begin to-day and make a correct report of every pipe in our street from these records. At various times these reports are taken to the draughtsman, who puts them into the maps. We have a complete record up to within a month or two of every pipe that is laid, and of every valve and connection in the city of Allegheny. I find, as Mr. Harbison says, that to trust to memory is a very deceptive thing. I sometimes think that I know exactly what size of pipe is in a certain street, but when I examine the map I find that I am mistaken. I find sometimes that it is a 6-inch main when I thought it was an 8-inch, or vice versa. I do not know that there can be anything more important for a gas superintendent to have, than a map of every pipe that he has, and of all the data that he can get to bear upon it. He will find that it will be of great importance and assistance to him.

Mr. Littlehales—It seems to me that the logical result of the paper, and of the discussion that has followed, to paraphrase an old remark, will be that from this time those of us will figure who never thought of it before, and those who always figure, now will figure all the more. (Laughter.)

Mr. Hambleton—The paper has my very decided approval, and is very much in accordance with my practice, except that it is carried out in more detail in some respects than I have been doing. I have been placed in a position where I have had to do a very extraordinary amount of pipe laying, and have had a good deal of pipe taking up to contend with; but I have man-

aged by dint of regular records to keep a thorough account of it, and have verified the accuracy of our maps, when changing the prices in different districts where a new company laid some hundred miles of pipe. A map was made and put down in the lower office, showing all the new pipe, and when a man came in to have his price changed because he lived in the opposition district, it coincided almost exactly. I have been obliged to keep a map of all the companies which have come to lay pipes in our territory (as well as of my own), and without that map we would have been absolutely lost, or in a hopeless tangle. But by dint of keeping such a record, and having everything in the way of pipe laying brought in and put on the map as soon as it was done, we have been able to keep our systems all separate and in perfect operation. One thing in addition to the locating of stopcocks that I have done is having an arrow showing the directions in which the screws turn. I have the book which has been suggested with a sketch of the location of all the stopcocks, and arrows to show the direction, so that any man can take that book and locate a stopcock, and turn it either shut or open with certainty. In the matter of the recording of data, I may say I have done a great deal in that line, and find it pays most decidedly. It has enabled me to make changes and improvements that I could not have made otherwise. I can only say I have no doubt that the paper of Mr. Shelton will be fruitful of a great deal of good. I have myself been greatly benefited by whatever I have done in that direction.

Mr. Shelton—I am very thankful to the gentlemen who have spoken so kindly of my paper. I will reply to two or three points which have been suggested. If Mr. Young's works are so much covered under the dirt that he cannot see them, and if they are in such a warm place that he has very little familiarity with them, that fact does not lessen the suggestion of my paper of the importance of having a record of what he does know about them. He can make a beginning, and adopt the practice of Mr. Harbison, and every time he gets a chance to put down another point, put it down, and then in the course of a few years he may have a complete record. In reply to Mr. Greenough's remark about the colors on the map, I will say I

am not here to lay down any empirical system, but simply to make suggestions. The company that I am connected with has found the system of coloring suggested in the paper to work very advantageously, and I recommend that. But of course there are many other ways which I presume are equally as good. Mr. Mooney raised the point that a gas engineer should not be a draughtsman. I do not agree with him in that.

On motion of Mr. Boardman the thanks of the Association were voted to Mr. Shelton.

Report of Committee on President's Address.

Committee on President's Address, having announced that their report was ready, Vice-President Boardman, at the request of the President, assumed the Chair.

Mr. Cowdery—In making the report upon the President's Address, your Committee found an unusual task before them. The Address contains so many points of interest, and so many valuable suggestions, that a great deal of time was necessary in order to give to each the proper consideration.

Your Committee reports as follows:

Gentlemen:—Your Committee respectfully recommends the close and earnest study of the masterly and unique presentation of the many points of interest embodied in the President's Address.

Your Committee especially calls attention to his remarks upon the municipal control of lighting, and its consequent exhaustive treatment.

The experience of conducting, with commercial success or failure, the manufacture of fuel gas must be, by virtue of the importance of such data, highly valuable to the modern gas manager.

Of equal interest, and treated with consummate skill, will be read the results of the increase of electric lighting.

We regret that it should be necessary to stimulate the lagging interest in the financial prosperity of the Association, of so large a number of the members, by calling attention to it,

and it is to be hoped that the next report of the Treasurer will show the healthy result of such a stern reminder.

We concur most heartily with and indorse the manly stand taken by our President in reference to establishing and maintaining the independence of this Association, and to this effect we recommend the adoption of the following resolution:

"That at all subsequent meetings no hospitality, in the shape of a banquet, be accepted by the Association, in the city visited."

The importance of designating beyond any peradventure the question of the tenure of office is concisely and clearly stated. In order to obtain the legality of the beginning and expiration of the term of office, and to avoid the misinterpretation likely to result from the ambiguity of the existing clause in the Constitution, we recommend the adoption of the following resolution:

"That it is the sense of the Association that, under the provisions of the Constitution, the officers-elect should enter upon the discharge of their respective duties on the Saturday succeeding the third Wednesday in October of each year."

And your Committee further recommends to the Council the following change in the Constitution, for final recommendation:

"That the election of officers take place immediately before the close of the final business session of the Association."

The approaching World's Fair demands that the large and varied interests of the gas profession be treated and displayed in a generous and liberal manner. In order to accomplish this, and to show the wonderful progress and genesis of the industry, it will be found useful and equitable to enlist the enthusiastic services of the kindred manufacturing industries which are integral to our business. To this effect we recommend to the Council that the ideas suggested by the President be carried out.

E. G. COWDERY,	I. C. BAXTER,	*Committee.*
O. B. WEBER,	W. H. BAXTER,	
A. G. GLASGOW,	G. S. HOOKEY,	

MR. MCCLEARY—I desire to ask whether the Address of the President is to be printed, except in the minutes.

MR. COWDERY—It was not intended to so recommend.

The Chairman—I think the President's Address is not separately printed unless so recommended by the Association; but it is printed in the minutes, and appears in the *American Gas Light Journal*.

Mr. McCleary—That is what I want to know; because some of us who are engaged by municipal corporations would like an opportunity to digest the Address.

The Chairman—You have heard the report of the Committee, and it seems to me that it covers quite a number of items; and it might be well, as the Address treats of such a variety of subjects, that you take up the recommendations of the Committee *seriatim*, cull out what you wish to pass, amend what you desire to amend, and then pass the report as a whole when you have thoroughly digested the matter. Shall we adopt it as a whole, or take it up in sections?

On motion of Mr. Fodell, it was determined to receive the report, and to discuss its recommendations separately.

The Chairman—The report is received. The first note I have made is in respect to municipal control. Is there anything you wish to do with that, or any recommendation further than the importance that has been attached to it in the report of the Committee? If there is no objection I will read that recommendation again: "Your Committee respectfully recommends the close and earnest study of the masterly and unique presentation of the many points of interest embodied in the President's Address. Your Committee especially calls attention to his remarks upon the municipal control of lighting, and its consequent exhaustive treatment."

On motion of Mr. Harbison, that recommendation of the Committee was adopted, without discussion.

The Chairman—The next point brought out is the increase of electric lighting, to which the Committee called the attention of the body, regretting that it is necessary to call our attention to it in order to stimulate and protect our own industry. What will you do with that?

Mr. Harbison—I move that the suggestion be adopted. (Carried.)

THE CHAIRMAN—The third point covered is the endorsement of the independence of the Association, and the resolution that, in effect, we furnish our own banquets hereafter.

MR. LITTLEHALES—I think that is an eminently suitable resolution to be adopted by the Association. While every member must feel that the places we have visited from time to time have been unlimited in their hospitality, yet I think the time has come when the Association should take an independent stand in that matter and decline all future hospitality. I have much pleasure in moving the adoption of that item.

MR. LANSDEN—Do I understand this is a recommendation that we shall not have a banquet, or does it only leave it in such a way that we can refuse or accept hospitalities at points where we meet? With regard to having a banquet, will not that question come up each year; or will it be settled this year for the next? And if we adopt that, do we settle the idea of whether or not we are to have a banquet and pay for it ourselves?

THE CHAIRMAN—There is no second to the motion, and if you will allow me, in order to bring it more fully to mind, I will read the resolution as it stands, and then you can discuss it more intelligently: "That, at all subsequent meetings, no hospitallty in the shape of a banquet be accepted by the Association, in the city visited." I think the point is perfectly clear.

(Mr. Harbison seconded the resolution offered by Mr. Littlehales.)

MR. GOODWIN—I would like to make a suggestion. While I concede that the resolution is eminently proper, still, if you ever come to Philadelphia we do not want to be blocked out, should we feel disposed to tender you the hospitalities of the City of Brotherly Love. If the resolution could be changed so as to read that it is the sense of this body that it should furnish its own banquets, the door is left open to such of us as might want to extend hospitality to do so. If that resolution prevails as it is, it would shut us out entirely. If it could be modified in the manner suggested, so as to make that the expression of

the sense of this meeting, I should be very glad to help pass it, and I know some others who would like to see that limitation.

Mr. Harbison—I hope the resolution as proposed by the Committee will not be changed in any respect, for it does not cut off our friends in Philadelphia or anywhere else from properly taking care of the ladies who may come with us, or from extending any other little hospitality our hosts may see fit to tender us—except the banquet. It only has reference to the banquet. There are many places where we can have a social dinner party on Mr. Goodwin's invitation, or on that of other distinguished men in Philadelphia, without having a set banquet.

Mr. Littlehales—There is no reason why Mr. Goodwin's suggestion should be favored. We know his largeness of heart, for we have had specimens of his treatment; and if we should have the pleasure of meeting in Philadelphia again, I have no doubt there would be the same large-heartedness still. I trust the motion will pass in its entirety, as it stands.

(The announcement of the Chairman that the motion was carried was received with applause.)

The Chairman—The next recommendation is as to the tenure of office. Following the preamble stating the necessity to fix some decided date for tenure of office, the resolution reads: "That it is the sense of the Association that, under the provisions of the Constitution, the officers elect should enter upon the discharge of their respective duties on the Saturday succeeding the third Wednesday in October of each year."

(On motion of Mr. Littlehales the recommendation was adopted.)

The Chairman—The fifth point to which attention is called is the change with regard to the election of officers—carrying it over from the third Wednesday, to the last day of the meeting which convenes on the third Wednesday.

Mr. Harbison—I move that recommendation be referred to the Council.

THE CHAIRMAN—I will read the recommendation so that you will understand it: "The Committee recommends the following change in the Constitution: 'That the election of officers take place immediately before the close of the final business session of the Association.'"

MR. HARRISON—I move the adoption of that recommendation.

MR. A. C. HUMPHREYS—If that resolution is adopted will the Council be able to act on it so that it shall come before this meeting, and so that it can be acted on at the next meeting?

MR. MCMILLIN—Yes; I think we can.

THE CHAIRMAN—I think it will be necessary to have the Council meet before the close of this business meeting. I may be in error, but I think that that is what would have to be done if it is adopted.

MR. A. C. HUMPHREYS—Could the Council have that meeting and act on the recommendation so that the Association can take it up provided they agree with the suggestion?

THE CHAIRMAN—I think the Council will promptly attend to anything that the Association requests. Are you ready for the question? (The motion was carried.) The recommendation is adopted. The Council will please take notice, and act accordingly. The sixth item before me is that with respect to the World's Fair. A suggestion is made by the President with respect to adding associate members to the Committee. That recommendation is taken up by the Committee on the President's address, who think that "It will be found useful and equitable to enlist the enthusiastic services of the kindred manufacturing industries which are integral to our business;" and to that end they recommend to the Council that the ideas suggested by the President be carried out.

MR. LITTLEHALES—I move the adoption of that. I understand this is to be taken in connection with the suggestion made in the President's address that no expense be incurred by the Council except they have the money in hand, so that it will not involve the Association in any expenditure.

THE CHAIRMAN—I think the idea of the Committee evidently is that the recommendations of the President shall be taken in their entirety. It is moved and seconded that the recommendation of the Committee in this respect be adopted. Are there any remarks? (The motion was carried.) The resolution is adopted. Will you take up the report now as a whole?

MR. SOMERVILLE—One other point I desire to call attention to, which I think you have perhaps overlooked among the recommendations of the Committee. The President made allusion to it. The subject is one which I have never before heard mentioned in a President's address. I was very sorry indeed that he was obliged to mention this subject. It was painful to me to hear it. It is painful for me now to speak about it. I think it is the duty of some member who is not an officer of the Association to call attention to it. Of course you all know to what I allude—the financial condition of the Association.

THE CHAIRMAN—I overlooked that. I am very glad you have called the attention of the Chair to that point. It is a very important matter. The recommendation of the Committee in this respect is: "We regret that it should be necessary to stimulate the lagging interest in the financial prosperity of the Association, of so large a number of the members by calling attention to it, and it is to be hoped that the next report of the Treasurer will show the healthy result of such a stern reminder." What is your pleasure as to this?

MR. LITTLEHALES—I move the adoption of the report. I will simply call attention to it. We will suppose that the members have merely overlooked it—a thing which they ought not to do, since we are all so fond of cutting off the gas when our customers do not pay. (Laughter.)

MR. A. C. HUMPHREYS—If it be a proper question I would like to hear what penalty the Constitution affixes for the non-payment of dues, and I would like to have the Treasurer report what amount of dues he has collected at this session after the very urgent appeals he has made. A reference to the unpaid dues having been made twice already at this meeting, I would like to know how much effect the reference has had.

The Chairman—I believe that that is not quite in order on the present motion.

Mr. A. C. Humphreys—Is it not in order to ask for any information from the officers of the Association which will help us in forming an opinion on the subject before us?

The Chairman—That is proper, if you ask for information.

The Secretary—The Constitution says, Article 51: "No member who owes 2 years' dues shall be entitled to vote or participate in the deliberations of the Association, or to receive a copy of the proceedings." The next Article reads: "Any member whose dues shall remain unpaid for a term of 3 years may be dropped from the roll of membership by a vote of the Council." On the other point I will say in reply to the question, that I have received the large sum of about $135, out of some $1,300 due.

Mr. A. C. Humphreys—May I ask one more question? How far have we followed the Constitution with regard to the distribution of records of proceedings? Do these members continue to get the proceedings, and has the Council been good natured about it, hoping that the dues would be settled up?

The Chairman—Perhaps the Secretary can answer that question.

The Secretary—Article 51 has not been enforced; Article 52, with regard to dropping members, has been enforced.

Mr. McMillin—I will say that we had a list made purposely and placed on the outside of the door, arranged alphabetically, so that each man could see whether he was two years behind or not, and we trusted to his honor not to take part in the discussions if he found himself two years behind.

The Chairman—I think Mr. Humphreys' question was directed to the distribution of the reports; was it not?

Mr. A. C. Humphreys—Yes, more especially.

The Secretary—I will say, in reply to that, that I have been instructed by the Council, when I had Vol. 9 prepared, not to send it to any member owing two years' dues.

THE CHAIRMAN—I think that answers Mr. Humphreys' question.

MR. LITTLEHALES—I would like to ask, in this connection, whether it is the understanding of the rule that when a member has paid up his arrears he retains his membership.

THE CHAIRMAN—I think so.

MR. LITTLEHALES—He is then reinstated?

THE CHAIRMAN—That is a matter which would properly come before the Council, I think. The Constitution provides that, "A member dropped from the roll for non-payment of dues may, upon paying the amount he owes the Association, be reinstated at the option of the Council."

MR. LANSDEN—I do not like to have the impression go out that a body of gentlemen who meet here as we have are not paying our dues; and I want to ask if it is not true that a vast majority of those who stand as delinquents are members who are not here. I do not wish to have the impression go out that those of us who are here, and a great many who have not the privilege of meeting with us, have not paid their dues. In looking over the list I see that a large number of the delinquents are members who are not present at this meeting. Although they are marked as delinquents, it is probable that they will pay their dues in a short time.

THE SECRETARY—We only have about 150 members here, out of 340. Of course, a great many of the delinquents are not present. I have not checked those who are present on that list, and so I cannot say just how many are present here who have not paid.

THE CHAIRMAN—Are there any further remarks on the question of adopting the President's Address? It has been moved and seconded that the report of the Committee on the President's Address be adopted.

(The motion was carried.)

THE CHAIRMAN—We will pass to the next business. Is the Committee on the place of the next meeting ready to report?

Report of Committee on Place of Meeting.

Mr. Littlehales, from the Committee, submitted the following report:

To the President and Members of the American Gas Light Association:

Gentlemen—Your Committee on next place of meeting beg to report that cordial invitations have been received from Hartford, Conn., and from Montreal, Can., and after full consideration of the question recommend that the city of New York be the next place of meeting.

Respectfully submitted,

John S. Bush, *Chairman.*

The Chairman—The motion is that the report of the Committee be adopted. (The motion was carried.) The report is adopted. New York will be the place of the next meeting. We will now listen to the paper of Mr. Fodell.

Mr. W. P. Fodell, of Philadephia, Pa., read his paper, entitled

SUGGESTIONS OF METHODS AND SYSTEMS FOR RECORDING THE HISTORIES AND ACCOUNTS OF GAS LIGHT COMPANIES.

Each and every business requires a different system for keeping its history and accounts, if not in the principal books used, at least in the auxiliary ones.

The machinery and tools employed in manufacturing, the labor expended, and products obtained, must be charged and credited respectively with their pecuniary value. The proprietors and the purchasers of the product must be registered, and their several accounts kept. The bills must be made, presented and collected. Finally, the profits or losses must be determined, and a division or assessment made among the proprietors.

In our particular field—the distillation of coal and other substances used for obtaining illuminating gas and other products

—I have prepared what I believe a proper division of the business into four departments, each having its distinct field and system of books, those of the first three converging into the last as follows:

First. Engineer's Department, for manufacture and distribution of the products.

Second. Registrar's Department, for registration of consumers.

Third. Receiver's Department, for rendering and collection of bills and forwarding collections to Treasurer's Department.

Fourth. Secretary and Treasurer's Department, for recording the acts of the managers, general supervision of the accounts and books, receiving all moneys, payment of interests, dividends and purchases.

In large works these departments would be sub-divided, and in small ones combined.

It is of prime importance that a careful and accurate note of each event, and record of each receipt and expenditure be made for present and future reference, that the exact history and cost of the operations may be determined at any time during the entire life of the concern. I suggest, therefore, that a complete set of books for this purpose be opened when the first bond is given or the first certificate of stock issued, and that the distinct charges to capital and profit or loss be accurately stated in each instance. There may at times be doubt in the mind of some as to which account certain expenditures should be charged. Some accountants fall into error by charging the expense of renewals to capital; but a moment's thought should correct this, when it is remembered that such items should properly be charged to profit and loss, for the reason that they take the place of once paid for machinery.

Betterments, such as extensions, additions and other improvements, in so far as they increase the capacity of the plant, would be properly chargeable to capital to the extent of the increased productiveness.

It is the custom of some manufacturing concerns, and it would seem a proper course to pursue, to charge, at certain periods, a per cent. of depreciation of the plant, where the machinery in use is being constantly worn away. This amount

should be sufficient to provide funds for the erection of an entire new plant at the end of a limited number of years.

Other concerns rate their capital not upon the actual cost but upon its productive value at the prevailing rate of interest. A corporation would be justified in increasing its assets by the appreciation of the real estate and other assets.

Another important matter to be carefully attended to in our business is to prepare and keep a plan of the plant, including street mains, with space for additions and extensions. It would also be of great advantage if all the pipes, valves, etc., in and about the works be exposed, so far as practicable, so that easy access could be had for alterations, repairs or stoppages; and for the facility that would be afforded for the location and detection of leaks. It would be of great advantage to gas companies if, in laying out a town, the streets could be tunnelled sufficient to lay all pipes, and even culverts therein, —as is the case in parts of Paris. Our leakage account would then be almost nothing, so easily could we detect, locate and remedy any leaks. The whole difference in the volume of gas between the station meter and the consumer would then be almost wholly condensation,—except leaks from service pipes, —and even these could be soon remedied if the service pipes were laid inside of larger pipes.

Before using the books of the subordinate departments, reference to the books of the treasurer is necessary; beginning with those of bonds and stock certificates, which having been issued, an entry is made in the cash book noting the cash receipts therefrom. Upon the purchase of a site, credit is taken in the cash book for the amount paid. Like credits are taken for the cost of the erection of the works, laying of mains, and purchases of machinery, tools, etc. Upon the completion of these important preliminaries, the cost of material, supplies and labor will similarly be entered on the cash book.

The plant having been completed, the material being on hand, and the laborers ready to begin business, the auxiliary books—*i. e.*, those necessary in the varied details of the business, must now be brought into use.*

*For forms of these books, see the little book published by A. M. Callender & Co., for me.

These books having been properly kept, the works in operation, the gas manufactured and distributed, and all the receipts and expenditures noted—at the end of six months or other desired period, by referring to these books, it will be found that they will reveal the component parts of profits earned, and also the losses sustained.

Making out the statement of profit and loss should be a very simple operation. First, the actual cash receipts from sales of gas, coke, tar, ammoniacal liquor, etc., and an estimate of the amount of gas delivered during the six months, for which the cash has not yet been collected; the value of sold and unsold coke, tar, ammoniacal liquor made during the six months. This is contained on one side of the statement. The other side should contain the storage cost of coal distilled during the same period; the cost of repairs, including those to stack, benches, etc., cost of labor of setting retorts, placing stand-pipes, mouth-pieces, etc., wages, taxes, rents, and current expenses. Deducting one side from the other will show the profit or loss.

A very important matter to be determined in the conduct of the manufacture of the gas, is its cost, as well in the holder as of its distribution and the management.

In finding cost in holder, for any stated period, we should charge the amount of coal or oil used at its storage cost; the wages paid in carbonizing, purifying, etc.; the cost of purifying material; the fuel used; the repairs and renewal of stacks, benches and retorts; the salary of the engineer, or so much of his time as is devoted to the manufacturing; proportion of water and taxes. In fact, all charges up to the holder. From these charges must be deducted the value of the coke, tar, and ammoniacal liquor obtained, and of spent lime left for sale—if lime is used—during the same period.

In obtaining the cost of distribution, include all costs of repairs, etc., wages and proportion of salaries, from and including the holder, up to manager's department.

The cost of management would be, salaries, stationery, etc., incident to the collections and general business.

The cost of gas must of necessity greatly vary in different localities, as the prices of material and labor obtain therein

It has been the practice of some to ask and expect those companies, far away from the coal mines, and where labor is comparatively high, to manufacture and sell gas at as low rates as those corporations who are located at the very mouth of the mines, and where labor does not command so high a price; and it is a sad commentary upon the intelligence of the age, to note the effort of municipal legislators to determine the price of gas by statute. Why this is the only one manufactured article singled out for this purpose, it is difficult to understand. Would it not be more just to go further back—behind this point—and fix by statute the prices of the material the manufacturers are obliged to use and the labor to employ?

Discussion.

THE CHAIRMAN—You have heard a very interesting paper, and I think the Secretary has made a good selection in having it follow the one just read—"The Engineer and his Pencil." Here we have the "Secretary and his Pen." The paper is open for discussion.

MR. SHELTON—I think this is a most important subject. There is evidently a necessity for keeping pen records as well as pencil records. I note that Mr. Ramsdell has just come in, and as I believe that he is on the Committee of the Western Association with regard to securing uniformity in gas accounts, I suggest that he might have something to say on this subject.

MR. RAMSDELL—I was called from the room, and so did not hear all of the paper which was read by Mr. Fodell; but I was very much interested in what I did hear. I think this is one of the most important subjects to come before our Association. From my study of the subject when getting up the report for the Western Association I found there was a great want of uniformity of system in keeping the accounts of gas companies, most companies having systems of their own. If I should have to write that report again I would change it a little from what it was as made. Having experimented a little since then, the change I would make would be in the distribution of the fixed charges. If you study it I think you will find it is quite a knotty problem, and one that requires a great deal of study to solve it

satisfactorily, so as to suit the various kinds of work and the various modes of manufacture. Mr. Fodell makes one change, and that is in the item of depreciation, which, in my report, was recommended to be treated as a fixed charge. Mr. Fodell's explanation of it as given in his paper would seem to cover exactly the same grounds; for he suggests the idea of laying aside for a number of years a fund which in time would be sufficient to re-erect the works. This would be the same practically as the plan which the Committee recommended in their report.

MR. LITTLEHALES—One item in reference to that has often appealed to me. It will be a great advantage to every member of this Association if it were practicable (as possibly it might not be) to follow the precedent set on the other side of the water. Often we fail to get as good results as we might by not knowing what our friends are doing. As you know, all the British companies publish the details of what they are doing. Probably that would not do for this country. If a scheme could be devised in any way by means of which we could each know the details of the other's working—classified and analyzed—it would be of immense advantage to us. I do not know whether that is practicable. I may say that I have for years past, in the companies I have been connected with, kept such a detailed record—taking the leading items for our balance sheet, and dividing them by the number of tons of coal used, so as to show each item of cost per 1,000 feet of gas made, and per 1,000 feet sold. I take the income and the capital, and divide them in the same way. It would be of great advantage to every one of us if some such system could be adopted. I do not know whether the feeling of the members would be in favor of publishing their accounts in that shape; but any member of the Association is welcome to see my accounts.

On motion of Mr. McIlhenny a vote of thanks was tendered to Mr. Fodell.

At this point the President resumed the chair and said—While Mr. Adams' paper is being distributed I desire to refer again to the report of the Committee on the President's Address. At the time the vote was taken on the adoption of that report another member was entitled to the floor or I would have made

my remark at that time. I want to say that, in my opinion, the Committee, out of some very common material, erected a pretty handsome edifice. I owe them my sincere thanks for the compliment paid me in recommending the adoption of the various suggestions which I made. I feel greatly complimented also because the Association adopted these suggestions. I think the Association really ought, and doubtless does, give the members of that Committee their thanks for the interest they manifested, and for the work they did in connection with that report.

We will now listen to Mr. H. C. Adams, of Philadelphia, Pa., who will read his paper on

THE GAS COALS OF THE UNITED STATES—THEIR GEOGRAPHICAL AND GEOLOGICAL LOCATION AND AREA, AND THEIR PHYSICAL CHARACTERISTICS.

In the contemplation of the subject of Gas Coals and their use, we are struck with the beautiful example they present of the conservation of energy. The sunbeams of thousands upon thousands of years ago, hidden in this form in the bowels of the earth, were apparently lost forever. But the wise Architect of the Universe does not waste material; and Nature, His handmaiden, though seemingly prodigal, ever works with careful economy of her forces to the desired end. So, after a lapse of ages of a duration almost incomprehensible to our minds, we find the energy and material absorbed in the formation of these coals, given out again by the hand of man in the form of light and heat at the present day. Surely this is a monument to design in the planning of the creation; a mark of wise forethought in an omniscient Providence, to whom, when these coals were formed, their use in future ages was part of the stupendous but symmetrical plan that built our world.

Is there not much food for thought in that light that makes bright our nights in the long buried but now regenerated sunbeam, that centuries ago fell apparently wasted upon the world? And if we incline to philosophize further upon the subject, may we not find that the bright colors, imprisoned deep in this black

Eugene Vanderpool.

mass of coal, do, when released, cause the flowers of the infant world to bloom again?

To turn now to the practical aspect of the matter before us, we find that a gas coal is technically and commercially known as one having, say, 30 per cent. of volatile matter, not over 1 per cent. of sulphur, and a low percentage of ash. But, as a matter of fact, the percentage of volatile matter is not so much the criterion as is the quality. For, as we shall find, a coal lower in volatile matter than another, may yet yield a greater quantity of richer gas, and be unqualifiedly superior for gasification. So while low percentages of sulphur and ash are essential pre-requisites of a good gas coal, the volatile matter is qualified by the question of quality. In a country like our own, where so many different grades of coal are used in gas making, it is difficult to precisely define a gas coal, save to say that it is such a coal as may be practically used in gasification in the production of illuminating gas. It must have, of course, a certain percentage of volatile matter charged with illuminating hydrocarbons. We may, perhaps, safely draw the line at or about 60 candle feet, and say that no coal is used in this country in gas making that yields much less than that quantity and quality.

The essentials of a good gas coal are a low percentage of ash, say 5 per cent.; and of sulphur, say ½ of one per cent.; a generous share, say 37 to 40 per cent., of volatile matter, charged with rich illuminating hydrocarbons. And it should yield, under present retort practice, 85 candle feet to the pound carbonized. It should also be sufficiently dense to bear transportation well, so that when carried long distances, it may not arrive at its destination largely reduced to slack or fine coal of the consistency of sand. And it should possess coking qualities that will bring from the retorts, after carbonization, about 60 per cent. of clean, strong, bright coke.

Our theme is readily divisible into two principal parts. The first of which, and the one to which we shall confine our attention in this paper, relates to the geographical and geological location and area of the gas coal deposits and their physical characteristics. The second part has to do with the relative commercial values of the different coals, and their behavior and re-

sults in gasification, and is beyond the scope of our present inquiries.

In considering, then, the geological, geographical, and physical aspects of the coals, we must begin at the beginning, and take our way with hasty footsteps along the pathway of creation, until we reach the carboniferous jungles that were the source and origin of our subject. Starting with the nebular hypothesis, for want of a better one, and gazing upon our world, a globe of gaseous matter suspended by the laws of gravity in mid-space, we see it cooling, solidifying, and shrinking, until we have a molten mass enveloped with a hardening, cooling, wrinkling crust. Then comes the precipitation of great masses of vapor, and the appearance of a universal ocean reigning supreme. Through this the tightening crust thrusts its wrinkled granite head, and we have the foundation of our continent. Against these attacks upon its supremacy Old Ocean fiercely fought, and dragged out into its depth great quantities of sedimentary matter, which, thickening as time passed on, placed the first story upon the house of our habitation. So went on through countless years the building of the world, until at last a great area of dry land in the northern part of our continent was raised by one of the volcanic throes that characterized this period. Upon this broad area, covering our Northern and Middle, and part of our Southern States, now ripe for planting, were sown by the Creative Hand the seeds of vegetation that burst forth with incredible luxuriance, and flourished and increased with wonderful prolificacy. Swamps and jungles grew, and fell rotting upon the ground, to be succeeded by others equally productive, and these again returned to earth to make way for their successors. Thus a great depth of vegetable matter was deposited; how great we may perhaps imagine, when we consider that it has been estimated that 1,200 years' growth of the most luxuriant vegetation of to-day would furnish the material for a coal seam of a thickness of only 6 inches.

Now, a sudden subsidence of the continent occurred, and over these vegetable deposits the ocean rolled, carrying with it and piling upon them masses of sand and mud which pressed heavily upon the underlying stratum of vegetation, and gradually but surely, in the slow process of Nature, changed it into

coal. The sand and mud in their turn become the superincumbent rocks, and we find we have proceeded one step in the formation of the coal measures.

Then another upheaval took place; again vegetation flourished. Again the giant ferns, clubmosses, and reeds spread out their leaves and branches. Then came another sinking of the land, another reign of Old Ocean. Again are the vegetable masses crushed under thousands of tons of sand and mud, and solidified, preserve to us in the form of coal the carbon that in the form of carbonic acid their greedy lungs had sucked from the atmosphere of those days. So, with like repeated processes, vein upon vein of coal is formed and the coal measures completed. Not, however, in their present area or condition, for subsequently glacier and flood wrought sad havoc in these fields, and the upheavals and disturbances of the unsettled earth crust distorted and displaced them. But here we see again the hand of a foreseeing, provident Architect. Had not these glacial, aqueous, and volcanic disturbances displaced these measures, had they not been cut into or lifted up, had they lain in their original planes, they would have been forever buried beyond man's reach and knowledge.

The conditions we have just described characterized what has been aptly termed the Carboniferous period; and it forms, with two small exceptions, the sole source of our coal deposits in our Eastern, Southern and Middle States. Subsequent like conditions at a later period, the Triassic, but upon a small scale, led to small deposits of coal in Virginia and in North Carolina, but they are of such restricted areas as to be of only local importance.

Upon a more extensive plan, however, were the deposits of a still later age, known as the Cretaceous, in which were formed the extensive but generally inferior coal fields of the western part of the United States.

The relative ages of these coal fields are determined by the fossils contained in the measures, which form ready and sure indices. The original deposits were probably all of a bituminous character, varying in kind according to the various conditions of pressure and locality. The difference in the quality of the volatile portion is probably due to the different kinds of

vegetation that entered into the composition of the coals in different regions. The physical treatment, of course, had much to do with changing the character of coals formed from identical kinds of vegetation. Beginning with peat, the first and lowest form of bitumized vegetation, and passing on through the bituminous, semi-bituminous and anthracites, we find that the laboratory of Nature formed them successfully, according to the conditions imposed upon them. An original bituminous deposit subjected to the heat and disturbance of volcanic action, has its volatile matter slowly distilled off, and there remains the carbon or anthracite. The degree and duration of heat in distillation regulate the quantity of volatile matter left in the original coal, and stamp its character as bituminous, semi-bituminous, semi-anthracite, or anthracite, or proceeding one step further, graphite.

Cannel coal is supposed to be the product of masses of finely macerated vegetable matter, collected in the form of carbonaceous mud, in lagoons or small lakes. This would account for its compact and homogeneous structure, and for the fact that it is generally found in small "pockets" of limited area. And it would account also for its retention of a high percentage of the original volatile matter contained in the plants, and for the high percentage of ash.

Now, taking a bird's eye view of the United States, the area under discussion, we see first a long deposit of coal stretching down from New York to Alabama, almost parallel with the sea coast. This is the great Appalachian field, the original and principal one. It lies in Pennsylvania, Ohio, Virginia, West Virginia, Kentucky, Tennessee, and crossing the northwestern corner of Georgia, terminates in the northern part of Alabama.

Next we find the middle coal field, lying principally in Illinois, but extending eastward into Indiana, and southward into Western Kentucky.

Then comes the western field of Missouri, Iowa, Nebraska, Kansas, Arkansas, and Indian Territory. Finally, we see the great cretaceous deposits of the Western States and Territories, whose areas and values have not yet been fully and accurately determined, but which are rich in promise. Through these fields we shall take our way in search of gas coals.

Starting in Pennsylvania, on the Atlantic seaboard, we shall pass southward to the Gulf, and thence again north and westward to the Pacific.

At the outset we must halt for some time in Pennsylvania. The importance of her deposits merits more lengthy consideration at our hands than do those of any other State, for from her coal beds are drawn the principal gas coal supplies of the Middle and New England States; and the West, the South, and Southwest likewise look here in some measure for their supply.

Pre-eminent as a coal producer among all the States stands Pennsylvania, whether we regard her vast anthracite formations, peculiar to her own confines, or her vast area of semi-bituminous steam coals; her great bed of world-renowned coking coal, or her magnificent area of standard gas coal. She sent out to the markets of the country in the year 1889 one-half of all the coal shipped over the wide area of the United States; and the next most active of her sister States, Illinois, sent out only one-fifth as much. Blessed as she is with all these various grades of coal, in none of them is she more fortunate than in her gas coal, having regard to quality, quantity, and accessibility, the three prime essentials. In speaking of gas coal, we need consider only, at present, that pre-eminent bed lying in the southwestern corner of the State, adjacent to the city of Pittsburgh, from which it derives its name—and which in area, uniformity, and quality is not approached in the coal fields of the world. It is spread over the five southwestern-most counties, and exposed to commercial operation in profusion in all directions by the erosion of the many and noble streams that flow through it. The Allegheny river to the north, Youghiogheny and Monongahela to the south, joining at Pittsburgh to form the mighty Ohio, are lined with coal mines along their banks, and expose long lines of virgin coal in the more remote regions, awaiting the expansion of the coal production that will necessitate their development. It seems as though such magnificent water ways had been made to order through this region, so manifold and so serviceable are they. These streams are wide and shallow, and Nature has to be assisted somewhat to render them navigable with any degree of regularity. Hence, great dams have been built across them

to back up the water and give a floating depth to the coal-laden barges and the steamers that tow them. These dams have been built at varying distances along the Monongahela, from Pittsburgh clear up to the Pennsylvania State line. There formerly were some in the Youghiogheny river, to furnish slack-water navigation there; but the fierce competition in the river coal trade, combined with the extension and competition of railroads, have forced them into disuse, and they have fallen to decay. Owing to the natural navigability of the Allegheny, no dams have ever been erected in its waters.

As a basis for the slack-water navigation of its tributary rivers, an immense dam was built at Davids Island, on the Ohio, a short distance below Pittsburgh. This provides for water up to the first dam of the Monongahela, opposite the city of Pittsburgh. Other dams at varying distances, to the number of seven in all, reach to within a few miles of the West Virginia line. The second dam is located 10 miles above the first, near the town of Braddock. The third dam is just below the town of Elizabeth, 12 miles or more above the second. The locations of these dams have been described thus minutely, because they have been used to define to a certain degree the limits of the best gas coal. The slack-water area between the different dams is known as a "pool;" thus the water between the first and second dam is known as the first pool; and the water between the second and third dam, or say, between Braddock and Elizabeth, is known as "second pool." In the latter term a well-known and generally used trade name will be recognized, designating the best grade of gas coal. This has come about, because the slack water above the second dam, extending down the Youghiogheny as well as the Monongahela river, lies in the belt of best gas coal, although it by no means defines its limits, but serves as a general indication of the quality required.

When the coal for river shipment is brought out of the mines in the pit wagons, it is run out into a dumping house or "tipple," as it is called in these regions. It is then "dumped" over separating screens into long, shallow barges waiting in the river below. Some of these barges will be filled with screenings, others with lump coal, etc., etc. The barges hold

about 500 tons, or 12,000 bushels each. These are then gathered into a "tow," representing sometimes 10,000 to 20,000 tons, 2 or 3 acres of coal, and placed in front of one of the river steamers, long, shallow craft, with a great stern-wheel, and pushed down the river, along the Ohio and Mississippi to the Southern markets, where the coal is sometimes held in large quantities and for a long time in storage, awaiting a rise in the market when coal becomes scarce through a "shut down" in the river workings, owing to the low stage of water, or from other causes. So much for the water ways.

In facilities for transportation by railroad, certainly this region is unapproached. Each of the great valleys that form the principal sources of coal supply has a railroad on each side of it. For the Eastern market the great trunk lines, Pennsylvania Railroad and the Baltimore & Ohio Railroad, are the carriers. For the Western, the Baltimore & Ohio, the Pennsylvania Company Lines, and the Pittsburgh & Lake Erie, with its connections, take the bulk of the tonnage. While northward to the lakes all those lines, with others of lesser importance, carry the immense tonnage shipped annually from Cleveland and other ports. Branch roads are run from the main lines of the roads along all the valleys that are productive of coal, and in most of these it lies cropping along the lines of railroads, so as to admit of the easiest and cheapest loading. The operations are rare where the distance from the mine mouth to the railroad car is over a few hundred feet, and it is generally much less than that. The coal, when brought from the mines, is run into the dumping houses, or "tipples," and "dumped" over the screens into the cars. That which passes over the uppermost screen, the bars of which are generally 1½ inches apart, is known as the lump coal; that which passes over the next lower screen, generally of bars three-quarters of an inch apart, is known as the nut coal; while the final small residuum is known as the "slack" of the coal.

Thanks to the magnificent work of her State Geological Surveys, the gas coal region of Pennsylvania may be readily defined and described. The measures that confine it belong to the Carboniferous period of the Paleozoic Age. The strata trend in an almost due northeasterly and southwesterly direc-

tion, slowly sinking into the earth as they pass to the southwest. Over their northeastern exposure, or crop, the plane of erosion has passed with glacier or flood, cut down the overlapping measures, and exposed the seams of coal to commercial operations, discovering them in their successive geological order. If these measures had been left in their original horizontal planes, the gas coals would have been sunk half a mile below the surface, and would have been immensely more expensive to reach and remove.

These carboniferous measures, some 2,600 feet thick, comprise within them all the coal beds, both gas and steam, of Western Pennsylvania. They have been separated by the Pennsylvania Geological Surveys into four divisions:

1. The Upper Barren, say 1,100 feet thick, containing several inconsiderable seams of coal, fit only for steam or manufacturing purposes.

2. Upper Productive, say 500 feet thick, containing 2 or 3 small beds of only local importance as steam coal, and having at their bottom, the famous Pittsburgh coal bed.

3. The Lower Barren measures, say 600 feet thick, from the Pittsburgh bed to the Mahoning sandstone—that useful geological landmark—and containing no workable coal beds.

4. The Lower Productive measures, say 450 feet thick, containing the Freeport and Kittaning coal beds, which in other parts of the States appear to a limited extent as gas coals, but are of great importance and value as steam coals, where they are more readily accessible and not contiguous to the Superior Pittsburgh seam. In the upper series of these coals are frequently deposits of amorphous cannels; of small value, however, for gas making, owing to their large per cent. of ash and sulphur.

At the base of all these measures lies the well-known Pottsville conglomerate, below which there is no coal to be found, excepting a few small and unimportant seams in the subcarboniferous measures. But some 2,000 feet below the coal measures here lie the famous gas "sands," *i. e.*, sandstones, running from a pebbly conglomerate to a fine, porous sandstone, in whose pores and interstices are confined the natural gas and oil that need only the tap of the drill to bring them rushing to the

surface of the earth. We have seen that as we descend into the depths of the earth we find only one considerable vein of gas coal in this locality, and that, the Pittsburgh, to which we shall now confine our attention. That seam, which erosion has placed within working reach only in Westmoreland, Washington, Greene, Allegheny, and Fayette counties, in fact, in the southwestern corner of the State, lies in successive shallow basins, with fairly well defined summits, *i. e.*, anticlinals, and troughs, *i. e.*, syclinals, to use the technical but now familiar names; these basins all have the northeast and southwest trend, with a gentle southwesterly dip. The dip or incline of the coal in the several parallel basins is generally gentle from trough to summit, though, owing to the narrowness of the basin, or to some irregularity in formation, it sometimes rises steeply up the sides. This comparative regularity of dip and trend is of great value in mining, and careful regard must be had for it. The economy of placing a shaft at the bottom of a basin, where it may draw upon coal with the aid of gravity from nearly three-quarters the area of a circumscribed circle, does not need lengthy demonstration. The coal bed has been nearly completely eroded from northern Allegheny county, while in the eastern part it is left only in isolated patches. In Westmoreland county it runs from a solid body, on the southern part, out to torn and ragged horns projecting out to the Conemaugh river, its northern boundary, where we can see how the anticlinals, or uplifted ridges, have been swept bare of coal, leaving it in the sunken troughs of the synclinals. Fayette County, too, has suffered from this erosion, but the vein lies solid and undisturbed in Washington and Greene counties, where it is deep beneath the sheltering cover of the superincumbent measures.

Now of this famous and magnificent vein, *facile princeps* among similar deposits, only a part is gas coal, properly called. As it passes to the eastward it becomes the famous coking coal of the Connellsville region, and to the southeast, the famous Cumberland steam coal of Maryland. The change in quality is gradual, but may be fairly well defined.

Roughly speaking, there is no gas coal in this seam in Pennsylvania west of Pittsburgh. As the vein passes to the westward of that point the per cent. of volatile matter decreases and the

structure of the coal changes somewhat, and becomes of a more dense character and what is known as "block" rather than a gas coal—and the richer hydro-carbons seem to have been lost. Taking Pittsburgh, therefore, as a starting point, if we travel northeastward along the Allegheny river, to, say, Logan's Ferry, we shall have traced the northwestern limit. If we pass thence southeastward to the town of Salem, in Westmoreland County, we shall have drawn the line of the northern extension. Then if, leaving Salem, we trace an arc of a circle southwestward, with Pittsburgh as a center, from Salem to Lock No. 4, on the Monongahela river, we shall have the easternmost boundary; and if we return thence to Pittsburgh, diverging slightly to the westward of a direct line, we shall have determined the boundaries of the area of the gas coal. That, it may readily be imagined, is a difficult and dangerous task. The lines named, however, do practically define the limits as commercially recognized. There may, of course, be some good gas coal without those lines, and there is some bad gas coal within them. To the eastward of Pittsburgh there is no gas coal beyond the Irwin basin, of which the town of Irwin, Pa., defines the trough. Passing beyond that town, over the next crest to the trough of which the town of Greensburg is the center, we find the coal softer, having lost volatile matter, and fit only for steam coal. The sulphur, too, rises as we go on to the east. In the next, or Connellsville basin, the volatile matter has fallen to 30 per cent., and the seam thickened out to 10 or 11 feet, entirely changed in aspect.

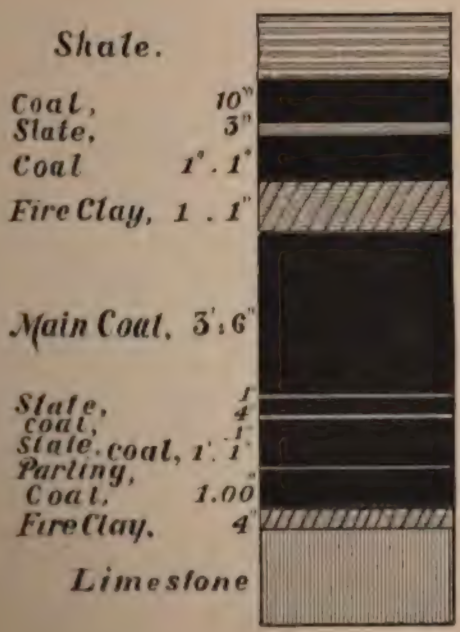
So, also, as we go southeastward up the Youghiogheny, and southward up the Monongahela, we find the coal thickening, the volatile matter lessening, and the sulphur increasing slightly; the coal gradually passing from a gas to a steam, and thence to the yet softer coking coal. The thickening of the seam as we pass up the river is occasioned by the disappearance of the impurities in the way of slates, etc., in the seam, permitting to be mined there what is found unmerchantable in the gas coal region proper. This thicker coal is mined and sold for a fixed rate below the better coal lower down the river.

To the southwestward of Pittsburgh the coal changes in character, as described in speaking of the coal directly west of it,

becomes more of the nature of a block coal; and soon after sing the Allegheny county line sinks below the upper meas-, and becomes, literally and liberally speaking, beneath sideration.

he available Pittsburgh coal bed in its entirety in Pennsylia is estimated to cover some 2,500 square miles — say 0,000,000 tons of steam and gas coals. In the region to ch we have confined the gas coal proper, only a very small cent. has been mined out. Over that whole area lies a body of virgin gas coal of the finest quality. Roughly, it be estimated (allowing 50 per cent. for wastage, etc.) at 5,000,000 tons—sufficient to supply the whole United States, as it may, for centuries to come.

Section.



In the gas coal region proper the vein is capped by a heavy sandstone, called the Pittsburgh, separated from the coal seam by only a thin seam of shale, which in some places disappears, leaving the sandstone resting upon the coal. The seam proper is divided into two divisions—the upper or roof division, and the lower division—the total thickness being from 9 to 10 feet. The roof division, being full of impurities in the way of sulphur and fine slate seams, is regarded as unmerchantable, and left intact, forming the roof of the rooms and entries of the mine. About one foot of fireclay, called "slate" by the miners, divides the two divisions, and this slate is always removed after mining away the coal beneath. It is responsible for more deaths in the gas coal mines than any other cause, for the reason that the work of mining beneath it works it loose from the roof coal; and while seemingly securely attached, a slight jar suffices to drop tons of it upon the heedless miner, and crushes him to death. In nearly every case, however, such an accident is directly the result of the miner's carelessness, born of the contempt for such menaces that long familiarity engenders.

The lower division of the seam, from which is cut the coal that is shipped to market, extends in a clean, solid mass from the "slate" just mentioned a distance of 3 feet 6 inches downward, constituting the "breast" of the coal, as it is called, and here is found the cleanest and best coal of the seam. Then two small 1-inch bands of slate occur, about 3 or 4 inches apart, that define the portion of the vein where the miner cuts in with his pick or his machine before he "breaks down" the coal, or loosens it from the overlying "slate." Below these slates again is a foot of good coal, which is taken up and shipped. Below that again, separated by a small slate parting, is a foot of bottom coal, as it is called, which, owing to its impurities, is left untouched in the mines. Below the seam is a fine four-inch band of fireclay resting on a shale or limestone. Thus, of a seam 9 feet to 10 feet in thickness, but 4 feet 6 inches to 5 feet is mined out.

This vein runs over the whole gas coal area with almost identity of structure, and with a wonderful persistence of form. Occasional breaks or faults occur in the form of clay veins, where, through some abrupt upheaval or rupture of the strata,

the breaks in the seam become filled with a mass of clay or shale through infiltration from above. Again, where the strata has been crushed or jarred together upon itself, what is called a slack vein will occur, where for a time the otherwise dense coal of the seam will be of a loose, sandy nature. Horse backs or roof disturbances, and swamps, or temporary subsidence of the coal below its normal level, or the erosion or even total disappearance of it, likewise disturb at times the regular progress of mining work. Near these irregularities the coal frequently loses its normal form and character, and at times presents a tough, gnarled, splint-like appearance, and loses much of its value as a producer of gas.

Physically, the Pittsburgh gas coal is of the highest class of bituminous coals—*i. e.*, the richest in bitumen. In appearance it is black and shining with a resinous luster. It is compact, and of sufficient density to "stand up" well, and to submit to the rough usage of transportation without crumbling or being ground by attrition to fine, powdery coal. In fact, after an incredible amount of tumbling about in the course of shipment and reshipment, it retains the large lumpy form in which it leaves the mines.

It comes from the mines in large cubical blocks, or nearly of that form, caused by its rectangular cleavage planes. The main plane of cleavage is a vertical one, running regularly through the region nearly north, 25° east, showing a clean, shining, smooth, vertical plane of coal. This cleavage or "face," as it is called, determines the direction of the driving of entries into the coal, so that in the working places given the miner to cut the coal, rooms, as they are called, he may work against and along this cleavage plane, being thus aided in the extraction of the coal.

The horizontal fracture is conchoidal, and striated through the coal in horizontal plane is always more or less mineral charcoal, in thin seams, with a branch-like structure, showing clearly the woody, fibrous nature of the carbonized substance representing some vegetation that, for some reason or other, suffered more complete carbonization than the surrounding masses. While generally present in the coal, its bulk is inconsiderable. Thin seams of amorphous cannel appear occasionally running

through the center of the vein. These, however, are of very limited area, and run from one to six inches in thickness, not sufficient to have any appreciable effect upon the average of the quality of the coal.

Occasionally small, white, scale-like deposits are found on the vertical faces of the coal. These are calcite or carbonate of lime, probably formed by percolation from superincumbent limestone. The quantity is, however, inconsiderable.

Now, in the matter of the discolorations so frequently noticed and so often complained of by gas engineers, they are generally of a nature that does not depreciate the coal in any respect for gas making, or, at the most, so minutely as to be incalculable. Sometime there will be a fine light-green or gray coating along the face, generally from coals mined below water level, which, however, is nothing more than silt or pulverized clay, which has found its way down from the superincumbent clays through the partings or cleavings of the coal. Again, through a slight efflorescence of sulphate of iron, a yellowish-white stain forms on the coal; but in this case, as in the others, the quantity is so small as not to affect the value of the coal at all.

But, however, when the coating becomes general and thick, and more particularly is of a rusty or reddish-yellow hue, it is almost always an indication that the coal has been mined near the outcrop, and is stained by the drainage of the surface waters through the coal carrying with them the clays or earth that stain the coal. In this case there is generally irridescence on the faces and on all the vertical fractures, caused by the percolation down the faces of thin films of oxide of iron, and the coal becomes rainbow-hued. Those coals mined near the surfaces are generally freer from sulphur than those mined further under cover, and higher in ash; bnt their worth as gas coals is considerably diminished, owing to a depreciation in the quantity and character of the yield of gas, due to the action of the continuous flow of the surface waters over them.

We now turn to the impurity of chief moment to the gas maker—*i. e.*, sulphur. Sulphur we must find, for sulphur in coal is like bark on a tree—it is always there, varying in quantity. It is principally present in combination with iron as iron bisulphide or iron pyrites. This occurs generally in thin brass-like

flakes, hard and brittle, with a bright, metallic luster, and hence the name for it of "fool's gold." It is also present at times in large flat scales, and again in globular masses of the size and shape of the familiar cobble-stone. The thin flakes or scales are universally distributed through the bed of coal; but, fortunately, the larger stones are of comparatively rare occurrence, and generally lie in well-defined groups or beds. When such beds are met it is the best mining practice to drive through or around them, and not to attempt to extract the stones as they come to light, and then market the coal. These sulphur stones, when in appreciable quantity, almost always occur in the upper and lower portions of the "breast coal," within well-marked limits.

The percentage of sulphur in Pittsburgh gas coal varies from $\frac{4}{10}$ to $\frac{6}{10}$ of 1 per cent. It should average about $\frac{1}{2}$ of 1 per cent. in the long run. Experiments have shown that besides the sulphur in combination with iron as pyrites $F_e S_2$, there is a varying quantity of free sulphur present; probably about 40 per cent. in the Pittsburgh coal, though that per cent. is variable. Experiments did determine, however, that whether sulphur existed in the coal free or as $F_e S_2$, it made no difference in the per cent. volatilized in the process of coking or carbonization. It was found that about 40 per cent. of the sulphur was volatilized in carbonizing; leaving 60 per cent. in the coke. But that per cent. of sulphur is precisely the per cent. the residual coke bears to the coal. Thus we come to the important conclusion, verified by experimentation, that a coal high in per cent. of sulphur will yield a coke of like high per cent. A coal foul with sulphur, therefore, cannot make a clean coke.

When subjected to heat, the Pittsburgh coal cakes and swells; hence the name "caking," as applied to it and others exhibiting a like characteristic. The volatile matter of the coal making its way through this intumescing, fusing mass, leaves a series of pores and cells, composed of the carbon of the coal; and if, after the volatile matter is distilled off, the heat be withdrawn, the familiar porous, cellular mass of coke is found.

In analysis, the standard Pittsburgh gas coal will, on the average, determine as follows:

Volatile matter	35 to 40	per cent.
Carbon......	54 to 58	"
Sulphur.............	$\frac{6}{10}$ of 1	"
Ash......................	3 to 5	"
Water, at 255....................	$1\frac{5}{10}$	"
Per cent. coke....	60	"

A glance over the above analysis suffices to show why this coal ranks as the standard gas coal of the United States; and why other coals are classed as good or bad, according to their approach to it. Here is represented the happy medium; no extraordinary yield of rich gas, with a tremendous evolution of sulphur; no high percentage of volatile matter loaded down with an over-balancing burden of worthless ash. The volatile matter yields a fair return; the coke is plenty, clean and merchantable; the sulphur within limits that admit of its ready and cheap elimination; the ash, representing the residuum of impurities, wonderfully low. In fact, if we must have sulphur and ash, as necessary evils, here they are to be found at a minimum.

The uniformity of structure and analysis over the immense area of this bed of coal is wonderful. The exhaustion of thousands of acres, the driving of tunnels or entries for miles, into and under the hills through the heart of the seam, bring to daylight and thence to market coal that is practically identical with that found at the beginning of operations.

This persistence of chemical and physical structure is of no small importance to gas companies. It enables them to predicate certain results in carbonization through a year's work or through a course of years. It gives them a constant as the base of their calculations, without which progress were impracticable. We need not fear comparison here with our English cousins. Their best gas coals average about the same as our standard coal in volatile matter. In ash they average better than we do, not running much over 2 to 2½ per cent.; but in sulphur, the far more important consideration, they average about double that of our standard coal. While as compared with the Provincial gas coals of this country, from the Cape Breton district, we stand decidedly superior, both in quantity and quality of gas; and also in freedom from sulphur, the Pro-

vincial coals containing nearly six times as much of the latter impurity; and finally, we excel in greater yield of a superior quality of coke.

The Pittsburgh gas coals first reached the seaboard markets in the early 50's. The coals from the Pennsylvania Railroad main line were the first brought forward. The Youghiogheny coals of the Baltimore and Ohio Railroads were considerably later, owing to the lack of necessary railroad facilities from that district, the railroad from Pittsburgh to Connellsville being then operated as a separate line.

When the first attempt was made to sell these Pittsburgh coals to the seaboard gas companies, it met with most decided opposition in the prejudice that existed in favor of Newcastle and Pictou coals. The gas engineers of those days could with difficulty be persuaded that any good gas coal could be found in the United States, and they were loath to try experiments with such unknown quantities. Finally, however, after long and persistent efforts on the part of those having in hand their sale, successive trials were made with these coals, with the never-failing result of their final adaptation as the principal raw material of carbonization. They promptly demonstrated their superiority over the Provincial coals, and their at least equality with the best of those from Newcastle. They became at once the recognized standard of gas coal, and their consumption has since kept equal pace with the growth of the gas business of the country. The use of these coals in the West and South, and generally in the interior of the country, has been cotemporaneous with the establishment and operation of gas companies, no other suitable material offering as a substitute or predecessor.

Leaving the famous Pittsburgh seam, we find only two other gas coal districts in Pennsylvania to command our attention. (1) The Reynoldsville region of Jefferson county, and (2) the Beaver river region of Beaver county.

In Jefferson county the lower Freeport vein of coal, which, in investigating the Pittsburgh seam, we found lying some hundreds of feet below it in the lower productive coal measures, rises both in position and quality, and is spread over the whole county, and of workable thickness wherever found; and while it

is principally of the composition best fitting it for steam coal, yet in certain localities it attains the dignity of a gas coal. This seam here lies in parallel troughs with the same northeast and southwest trend that we found in the Pittsburgh coal, and it is of best quality and principally mined in Winslow Township, on the eastern edge of the county, in the basin or trough in the center of which the town of Reynoldsville lies, and to which it gives its name. The coal from this region reaches the markets of the North and Northeast, where it is principally consumed, by way of the Buffalo, Rochester and Pittsburgh Railway and the Western New York and Pennsylvania Railroad. Owing, however, to the incursions of the superior Pittsburgh coal at low prices over competitive routes, the use of this Reynoldsville coal for the manufacture of illuminating gas has practically ceased. Its gas making properties, however, fully justify its consideration here among the gas coals of Pennsylvania. As a steam coal, it is mined and shipped in large and constantly increasing quantities, and it is from this region that the Northern and Northeastern markets principally depend for their steam coal supply. In physical appearance, the coal is bright and lustrous and compact; but it has not so deep a resinous luster as the Pittsburgh, nor is it so dense. Hence, from its greater friability, it does not stand transhipment so well. It has numerous charcoal partings throughout, and is quite pyritous. The total thickness of the vein here is some 15 feet, but the upper part of it is composed of successive thin strata of coal and fireclay, and only the bottom member, 5 to 6 feet in thickness, contains merchantable coal.

A fair average analysis of the best of this coal is:

Water, at 225....	1.12 per cent.	
Volatile matter............	33.00 to 35.00	per cent.
Carbon....................	60.00 to 59.00	"
Sulphur	1.27 to 1.43	"
Ash......................	3.00 to 5.00	"

The Beaver county region owes its existence to the presence along the valleys of its rivers, at accessible points, and in workable quantities and merchantable quality, of the Darlington or Upper Kittaning seam of coal, another of the veins of the

Lower Productive measures lifted into prominence through the rise in the measures, and the absence of the Pittsburgh coal. This Kittaning seam is very irregular in thickness and character through Beaver county. On the average, however, it runs from 2 to 3 feet thick, not of a dimension to recommend it to extensive development, as thin seams of coal are necessarily troublesome and expensive to mine.

At Darlington, in Beaver county, it attains a wonderful thickness, and carries with it a thick vein of cannel, a purely local deposit, however. The seam here is at times some 20 feet in thickness. At the bottom is a small bituminous seam 1½ feet thick, then comes 6 to 12 feet of cannel, and above that again some 6 feet of cannel, gradually passing into a cannel like shale. Sometimes so much as 12 feet of good cannel have been taken from this deposit, but the average is about 6. The area of the gas coal is found in Darlington and Beaver Townships, in Beaver county, and up along the Big Beaver Valley in Lawrence county. The coal here, however, has met the same fate as that of Jefferson county. The advent of the cheap and superior Pittsburgh coal has ousted it from any market as a coal for the manufacture of illuminating gas. The cannel, of course, continues so to be used; but it, too, suffers from the competition of the superior Southern cannels.

The cannel is of conchoidal fracture, compact, with dull, lusterless appearance. It analyzes:

Water	1.160
Volatile matter	48.015
Carbon	38.241
Sulphur	.599
Ash	11.985

A very respectable showing.

The gas coal of this bed is compact, bright, with clear, resinous luster; in places it is remarkably pure, though generally high in sulphur. An average analysis is:

Water, at 225	1.78
Volatile matter	40.00
Carbon	49.00
Sulphur	3.00
Ash	4.06

In West Virginia we find the remaining two of the three principal gas coal regions of this country. In the northeastern part of the State lies the "West Virginia Gas Coal" region, as it is commercially known, and in the southwest lies the great Kanawha field. This State is blessed above all of her sister States, with few exceptions, in the richness and extent of her mineral deposits. Steam, gas splint, and cannel coals all abound within her borders. On every side is coal of one or another quality to be found. Of the 54 counties in the State, only 6 lack workable coal beds.

The coal measures of West Virginia are of the same general system as those described in Pennsylvania, of which they are an extension. In the northern part of the State we find the Pittsburgh bed, and in the southern part, the lower measures furnish the various seams. So far as gas coal is concerned, we may make two great divisions: (1) the West Virginia region, lying in the Monongahela Valley; (2) the Kanawha region, lying in the valley of the great Kanawha. To the first of these we will now turn our attention. The same river, the Monongahela, almost synonymous with coal, along whose banks, in Pennsylvania, we found gas coal lying in such abundance, crossing the Pennsylvania State line, flows southward, forking out to the southeast and southwest, through the northeastern part of West Virginia, and cutting down through the superimposed strata, exposes the Pittsburgh seam again along its course through Monongahela, Marion, Taylor, and Harrison counties, and defines the gas coal region. Through this broad valley runs the Baltimore and Ohio Railroad, the outlet of this region to the various markets, East and West. To the eastward the coals pass along the Baltimore and Ohio rails to Baltimore, where they are transhipped into vessels and carried to the gas companies of the Atlantic seaboard, and in this direction the greater part of the tonnage is carried. Outlet is had to the Northwest and to the Lakes at Cleveland by way of Wheeling; and to the West and South by way of Parkersburg branch to the Ohio river. Grafton, in Taylor county, represents the railroad center of the region, and from that radiate the various branches of the Baltimore and Ohio, carrying the coals to the markets above described. These coals appeared

in the markets early in the history of gas making in this country, and were among the first United States coals carbonized. In the early 50's the shipment of them to New York, Philadelphia, Boston and Baltimore was begun, and in spite of the competition of other and more newly developed regions, it is still maintained. Owing to the fact that many of the operators coke their screenings, large-sized screens are found among these mines; in fact, they run from ⅝-inch to 3-inch apertures. This should make the proper cleaning of the coal an easy matter, and more than compensate for the lesser density of the coal and their greater liability to loss from attrition than the Pennsylvania coals in being carried to market.

The Pittsburgh seam, which underlies the whole northwestern half of the State, and which is found again in the easternmost counties and across the Maryland State line as the famous big vein Cumberland coal, is the sole source of gas coal in the West Virginia region. While it is mined along the Ohio river on the western border of the State, and in other parts, it is nowhere of the sufficiently strongly marked "gas" character as in this district. We may name Monongalia, Preston, Taylor, Harrison, and Marion counties as defining the gas coal area. There are no gas coal operations east of Newburg, which lies close to the eastern crop of the seam, nor west of Wilsonburg, beyond which point the vein sinks, to rise again as it approaches the Ohio river. The coal measures here lie in the parallel northeast and southwest basins which we found characteristic of the Pennsylvania coal measures. The light dip of the coal in the wide basins and the general parallelism of the strata render mining easy. The coal is everywhere within easy reach in the Monongahela Valley. At Newburg, on the east, it is found in the hilltops; at Fairmount and Gaston it has fallen to the level of the railroad. So accessible is it that there is only one shaft in the entire district. Fairmount, in Marion county, may fairly represent the center of this region. As we go thence down the Monongahela we find the quality of the coal deteriorating, and becoming more impure and sulphurous. Following the valley to the south, below Clarksburg, we find the seam thinning out, and the coal falling in value. At Clarksburg and Fairmount, and between those two points, the coal is a magnificent seam,

running from 8 to 10 feet of clean coal. The entire section of the seam here is 15 feet. The first 4 feet compose an intermixed shale coal and slate roof division; then comes the main bench, say 9 feet of good, clean coal; then, below a small, 3 inch parting, comes an 18-inch bottom bench of poor, slaty coal. The whole 9 feet of coal is taken out, being undercut at the bottom. Such a splendid breast of coal should afford an opportunity for bringing out coal in first-class condition, with little labor and expense. This main bench of coal is generally clean and free from slates, though they occasionally occur near the top. In density the coal is nearly equal to the Pittsburgh coals of Pennsylvania. It has a clear, sharp, cubical cleavage and conchoidal fracture. The cleavage, at times, however, is seen as slaty or splint-like, bringing out the coal in long slabs, instead of the familiar cubes. The luster of the coal is bright and resinous. It has, in fact, the same general characteristics as the Pennsylvania coals. Through its lesser density it does not bear transportation so well, and has a tendency to slack in rehandling and transhipment, which of course, reduces its value for gasification at that point of delivery. It is, further, highly pyritous, and, in fact, the chief inferiority of this coal to the Pennsylvania coal is in its greater sulphurousness. All through the region it is impregnated with this impurity, which runs extremely high towards the limits of the gas coal area, and which really, to a large extent, defines it.

The two mining centers are Fairmount, in Marion county, and Clarksburg, in Harrison county, and around these two towns are grouped the principal mines of the district. While the general characteristics of the coals in these two districts are the same, yet generally speaking, the coal near Clarksburg is likely to be more sulphurous than that around Fairmount. Locally, the coals of the West Virginia region vary so, that it is difficult to give a general statement as to their chemical composition. An average of a large number of analyses of the standard coals gives the following approximate determination:

Volatile matter....................	35 to 40	per cent.
Fixed carbon......................	53 to 57	"
Sulphur	1	"
Ash................................	4 to 7	"

In gasification, this coal, owing to its high percentage of sulphur, is rarely used "straight;" but generally in a mixture with other less sulphurous coals.

No mention of the gas coal districts of West Virginia would be complete without mention of the once famous Ritchie mineral, a species of asphalt that was found in a vein 4½ feet thick, vertically, extending over a small area in Ritchie county. This pocket, as such small isolated deposits are generally called, was soon exhausted, and the supply ceased.

The deposit closely resembled the Albertite of the Province of New Brunswick, and, like it, proved of great value as an enricher of coal gas. It analyzed 55 per cent. of volatile matter, 42 per cent. of carbon, and only 3 per cent. of ash. It gave 26 to 28 bushels of fair coke to the ton carbonized—a favorable comparison with the best cannels of to-day.

Passing on southwestward we come into the great coal-field of the Kanawha Valley. The containing measures here are the equivalents of the Lower Productive, *i. e.*, the Freeport and Kittaning, veins of the Pennsylvania series, and are of great thickness and commercial value.

The Pittsburgh seam, which has heretofore furnished the principal field for our inquiries, does not enter to any considerable extent the field of the Kanawha Valley operations. Its outcrop or limit passes southwestward through almost the centre of the State, strikes the Kanawha River near the western boundary line of Kanawha county, passes on down into Campbell county, and turns thence northwestward into Ohio. And, while it is worked at points along the Kanawha River between Kanawha county and its junction with the Ohio, yet it is so small a factor comparatively with the enormous developments in the lower measures further up the river, that it deserves mention only as defining the southernmost limit of that famous seam.

The Kanawha River, which defines the important region to which it gives its name, has its head waters in North Carolina, thence they flow northward across the western half of the State of Virginia, and entering West Virginia near the point where Mercer, Summers and Monroe counties join on the State line,

flow northwestward, across the southern half of the State, to Point Pleasant, where they meet the Ohio River.

The Kanawha proper extends only from the Ohio to its junction with the Gauley River, near Kanawha Falls. Above that, it is known as the New River. The river system has been described above at length, because it so clearly marks the scene of operations in the coals, and, roughly speaking, its divisions likewise divide the grades of coal for our purposes.

The New and Kanawha rivers have really no valleys, in the sense of broad areas of level country, contiguous to their course. They run in a deep and narrow cañon, which they have worn down through the Lower Productive measures, exposing the various coal seams at successive levels along their precipitous banks. We find here the same characteristic that held of the Pittsburgh seam, in our researches through its course to the northeast of this region, *i. e.*, the gas coals on the west, and the steam and coking coals on the eastern side of the field. Along the New River lie the great fields of steam coals to which that stream has given name; while on the Kanawha proper, from Kanawha Falls to Charlestown, and extending, say, 30 miles north and south of the river, we find the gas coal region, or the area of the best gas coals. From Kanawha Falls, westward, these veins lie above water level; but near Charlestown, as they approach the Pittsburgh seam, they sink, and pass below water level, and out of the reach of commercial operations.

There are exposed in that district 4 or 5 seams of coal along the river bank. The lower one lying, to take a typical section, some 20 feet above the river level, and containing 4 feet to 4 feet 6 inches of good bituminous coal. Then next above, perhaps 100 feet above, comes the second seam, 6 feet 7 inches thick, containing the gas coal. Further on, at 500 or 600 feet elevation, is found a vein of splint coal, about 100 feet above which, in a splint seam some 6 feet thick, comes in the famous cannel of this region. And capping all, about 800 feet above the river, is found a seam of some 6 feet block coal. Thus, taking a fair example of the river bank, we see an extraordinary exhibit of seam upon seam of coals of different but all of good quality, exposed at accessible points, and all of workable thickness.

The moderate dip of the measures to the northwest, 40 to 60 feet to the mile, permits of easy and cheap mining. The coal when brought out is lowered to the river on inclined planes, and there "tippled" into boats or cars, as may be desired. The gas coal seam, which is known as seam No. 2, runs from 4 to 7 feet in thickness, made of 3 benches with clay partings, and with seams of splint, 4 to 14 inches thick, interstratified. The coal itself is clean, with a clear black, resinous luster, of cubical cleavage and conchoidal fracture. Its density is not quite so great as that of the Pennsylvania gas coals, and it consequently suffers more than they do from attrition of transhipment. Its general preparation for market is the same as that of Pennsylvania coals, save that it is screened over one and one-half inch screen to increase its lumpiness. It is also more highly sulphurous; but with those two exceptions it is quite the peer of the Pittsburgh coal, giving a large yield of high-candle gas, and having a very low percentage of ash. This region possesses very valuable facilities for shipment to the markets of the East, West and South. The United States Government has built a very extensive and complete system of free slack-water navigation on the Kanawha, similar to that described in the Monongahela. And by means of it the Kanawha coals are shipped by water at very low rates to points along the Ohio and Mississippi valleys, where they have become very large and dangerous competitors of the Pittsburgh shippers. The only rail carrier of these coals from the mines is the Chesapeake & Ohio Railroad, which takes them to the markets of the West and Northwest by way of Point Pleasant. To the Eastern market they are carried by rail to Newport News, where extensive shipping piers are erected, and shipped thence by vessels to the various gas companies of the Atlantic seaboard, where they are no inconsiderable factor in the gas coal market, which they first entered about the year 1876. They are, however, owing to their general high percentage of sulphur, compared with the Pennsylvania coals, for the most part used in admixture with the latter, and only in a few instances are they carbonized "straight."

Analysis of the product of some of the various gas-coal mines in this region determines:

Volatile matter....	35.1	40.42	34.91	33.92	37.357
Carbon...........	64.9	56	61.75	61.96	56.257
Sulphur	1.48	(not given)	(not given)	.65	1.286
Ash..............	2	3	2.40	2.35	3.850
Water............		.50	(not given)	1.12	1.250

Valuable deposits of cannel coal occur in this region, the chief of which is in the neighborhood of the town of Cannelton. These deposits are, as usual, in the form of pockets of limited area, and generally referable to seam No. 4, or the supposed equivalent of the Upper Freeport seam of Pennsylvania. The cannel is found interstratified with splint or bituminous coal, and of varying thickness, though at Cannelton it gives 3½ feet. These cannels are of the usual dull gray slate color, and lie in the vein in layers, with a well-defined parting. Owing to their density and position, they are expensive to mine. They are extremely hard, and difficult to break in the vertical plane. Horizontally, they break with greater readiness, showing conchoidal fracture. Originally, this coal was mined for distillation for oil; but about 1873 was brought into the market as a gas enricher, where it has since held a position as one of the standards. There are in this region, no doubt, many valuable deposits of cannel as yet undiscovered, which further development of the coal-field will bring, literally and liberally speaking, "to light." At present, the extensive use of oil as an enricher of gas, curtailing as it does the use of cannel, does not stimulate investigation of the available area and supply of this grade of coal.

In an analysis, this cannel yields:

Volatile matter................	43.10	and 58
Carbon	56.90	23.50
Ash	7.40	18.50
Sulphur	1.162	(not given)

Mr. E. V. D'Invilliers, in his early and extensive investigations in the great Flat Top region about Pocahontas, suggested the likelihood of the same conditions prevailing in that region, in regard to the relative qualities of the coals in the wide area extending thence westward through Virginia and northwestward through West Virginia and Kentucky along their mutual

boundary line, as we find in the Pennsylvania and also in the Kanawha fields. That is to say, a gradual increase in volatile matter as we pass to the west and northwest. Hence, we would expect to find gas-coals or coals of approximate character as we pass to the west and northwest along the line indicated through the Quinnimont (the Conglomerates of Pennsylvania) series of coal measures, as they are termed in this region. Very recent research on an extended scale along the proposed Ohio extension of the Norfolk & Western Railroad, northwest from Pocahontas, Va., to the Ohio River, through Martin county, Ky., and Wayne and Logan counties in West Virginia, has justified that inference. Coals have been disclosed, high in volatile matter, and, so far as analyses and physical characteristics go, suggestive of valuable gas coal. They have not yet, however, been subjected to test in gasification, so that all that can be said is, that it is likely that that district contains a large area of good gas coal. As we found the West Virginia field lying southwest of the Pennsylvania coals, and the Kanawha southwest of the West Virginia, so we find the district in question lying in a continuation of that southwest line through the Kanawha field.

Investigations pursued in the southeastern end of the field in the valleys of Coal Creek in Tazewell county, Va., and in adjacent districts along the Clinch Valley Division of the Norfolk & Western, show that of the three seams generally exposed, one shows indications of a good gas coal, in a seam likely to average three feet clean. The analyses of samples indicate a good coal, and, so far, tests on a small scale have borne out the prophecies of the analyses. The working has not, however, as yet been of sufficiently extended character to warrant a positive statement as to the qualities for gasification. The most important question yet to be determined is whether the seam will run, on the average, sufficiently thick and clean to enable it to be mined readily and profitably. That, only further development can decide. I understand that active operations towards that end are to be undertaken at once.

Turning aside for a moment from our southwesterly course, we find in the vicinity of Richmond, Va., a small but interest-

ing deposit of coal, running from a high bituminous to a natural coke, *i. e.*, where the igneous action has been more rapid than in the case of anthracite, and a less perfect result attained in carbonization. These deposits were of a much later period of continental life than the coal fields of the western part of the State, and are believed to have been formed in what is known as the Triassic Age. The deposits of the bituminous coals are in places extremely thick, running as high as 40 feet. The best presents the following analyses :

	Clover Hill.	Midlothian.
Ash	10.132	14.73
Water	1.339	2.55
Volatile matter	30.984	29.73
Carbon	56.831	53.01
Sulphur	.514	.580

While these analyses make a good showing, yet in actual practice the coal as shipped to market is so highly charged with sulphur, and carries with it so large a percentage of ash, as to make it practically of small value in gasification in the presence of the superior grades of gas coal found in the markets to which it could be shipped. These Triassic coals have been used on a small scale in gas making, but in the short time at our command no recent record of its working could be obtained. Little work has been done in this field for many years.

There are also in North Carolina two small areas of Triassic coal. Little work has been done in these fields, likewise, of late years; but some of the coal, from what is known as the Deep River field, has been used in gasification, with results said to be satisfactory. But of this no record could be had.

The coal-fields of Kentucky are of two principal divisions, the eastern and the western. The eastern is of the Appalachian system of coals, and is an extension of the Kanawha and West Virginia and Southwest Virginia deposits, and covers the eastern half of the State. The western division is an extension of the great middle or Illinois coal-fields. Kentucky, in her eastern counties, is rich in coal veins. Her coal-measures are tilted over at an inclination that exposes successfully their whole section. A dozen or more seams are found,

all persistent and recognizable, in different and distant localities. She has been blessed, however, rather with number than excellence. Of the whole ten principal veins of coal none is of such uniform thickness as to make it of great commercial value. At times they show workable thickness of excellent coals, but the seams vary so, both in sections and in physical quality, that little dependence can be placed upon them. It is unlikely that they will be extensively developed while in the adjacent States thick veins are accessible. As in number of seams, so in variety of coal. We find nearly everything but anthracite here. The principal formations, however, are splint or block coal and free-burning, non-coking, bituminous. Good coking coals are found, but gas coals are a rarity; and where they are discovered, none are of such generous formation as to make it likely they will ever be a considerable factor in the market, though analyses of local coals show excellent chemical compositions. The comments made upon the eastern coal-fields will serve as well for the western field, so far as general characteristics and its status as a producer of gas coal are concerned. The various seams, running from shale or bituminous coals to cannel, have made numerous and underspread deposits of the latter. It can be found in one or the other of the several seams, in varying quantities and of varying quality, nearly everywhere in the area underlaid by these coals. At times and in certain localities it attains an excellence of quality and magnitude of area that have made it a commercial possibility, and it is from this State that the majority of our best known and most desirable cannels come. To these we will now turn our attention. Of Kentucky it may be said that no other State has such a large area of rich and thick cannels. They are found in both the eastern and western fields and of good quality in nearly every county in the State underlaid by coal. The best cannels of the eastern field are generally found on what is known as seam No. 4 of the upper coals; but it is impracticable to relegate the best cannels in either field to a particular seam, so difficult is the determination of their equivalency. The cannels are found here, as elsewhere, in detached basins, in pockets of variable extent in area, and of no uniformity of thickness; hence, any estimate of their area in any locality is

largely conjectural. The vein is generally very thin, running from eighteen inches to three feet, and composed of superimposed thick lamina, like slabs of slate placed one upon the other, underlaid by inferior shale or bituminous coal or clays.

Through these underlying strata the "bearing in," or undercutting, is done. The mining is generally very difficult and expensive. The color is the familiar dull, slaty gray, with, at times, highly polished fracture, which is always conchoidal. The coal is remarkably dense and tough, and strongly resists cross fracture, while it parts with comparative ease horizontally in the line of the lamina. These physical characteristics give it, of course, a structure that resists the rough handling of transportation, and admits of its being carried the longest distance in good condition. The chief carrier through the State is the Chesapeake & Ohio Railroad, though those coals along the Ohio River are loaded on barges and shipped along that great waterway to the Southern and Western markets. In some instances these cannels were first developed for the distillation of oil prior to the discovery of the large fields of free natural oil; as many as 120 gallons of oil being distilled, it is said, from 1 ton of the best of these coals. In the eastern field, Greenup, Carter, Boyd and Johnson counties are the principal producers of cannels; though in the centre of the field, about the head waters of the Kentucky River, in Breathitt and adjacent counties, excellent deposits are discovered. In the western field, Hancock and Breckinridge counties are the chief producers, and are famous the world over for the excellence of their coal.

The analyses submitted below will show the comparative composition of these coals in the various localities:—

	Pike County.	Perry County.	Breathitt.	Breathitt.
Volatile matter......	43.4	44.16	68.28	53.8
Carbon...............	46.3	49.4	29.73	45
Sulphur.............	.689	.766	.83	.722
Ash................	8.3	6	3.64	5.54

	Hancock and Breckinridge.	Breathitt.	Greenup.
Volatile matter.......	60.90—77.5	58.80	47.46
Carbon...............	27 —21.05	35.30	38.84
Sulphur..............	1.89	4.07	1.55
Ash.................	12.10		12.40

These analyses will serve, in a general way, to show the range of quality and the general characteristics of the coals. In coking they vary greatly, some producing a good merchantable quality, that may be readily mixed and sold with that of coking coals; while others, and the majority, make a small, soft, friable, and nearly worthless coke. The best of these coals compare favorably with the best English cannels and approach the celebrated Australian shale, and are already shipped to foreign countries in competition with them. So favorable have been the results of comparative tests that a large export trade in the future is confidently looked for. It is a matter for congratulation that the determined area of some of the most valuable deposits reaches over a wide extent of country, running into the thousands of acres in some instances, thus insuring a practically limitless supply. Inadequate railroad facilities have been the chief obstacle in the way of the more rapid development of Kentucky cannels.

It is likely that the activity in railroad extension and industrial development through the South will render the markets of this country and of the world more readily accessible to the already developed coals, and lead to the discovery of many valuable, but as yet unknown, deposits.

The coal-measures of Tennessee are an extension of those of Kentucky, and, entering from that State in a belt some seventy miles wide, continue the general southwest trend through the State, generally narrowing as they pass southward until they enter Alabama, cutting across the extreme northwestern corner of Georgia. They occupy and are entirely confined to the Great Plateau of the Cumberland Mountains, a vast, narrow table-land running entirely across the State, north and south. There is no systematic geology of the State of recent determination, and as the Government make little or no provision for the compilation of statistics, or the filing of general information as to the progress of development of her coal fields, individual reports must be relied upon entirely. Therefore, it is difficult to make a complete or exact statement covering the whole area of her coal field.

We may divide the field into northern and southern divisions. In the southern the coals are of a semi-bituminous character,

and generally quite soft and friable, and extensively mined for the manufacture of coke; but towards the northern border of the State, in Scott, Campbell and Anderson counties, some very good gas coals and some excellent cannels are found.

These coals lie in the upper coal-measures, in which are found in this district eighteen or more different seams of coal, all varying in thickness and in quality, and changing at times from bituminous coals to cannels or shales, as we found to be the case in the Kentucky fields. Most of the seams are thin and irregular and worthless, but there is one seam, to which each successive explorer has given a different name, that is of comparatively uniform and persistent thickness, and which furnishes the best coal, and the gas coal and cannel, in the northern field. In the vicinity of Jellico Mountain, in Campbell county, is found an excellent grade of cannel, which has been extensively shipped through the county for the purpose of gas enriching. The deposit is estimated to cover some twelve hundred acres, which insures its permanency in the markets. The coal analyzes as follows:—

Volatile matter	49.85
Carbon	35.03
Ash	15.12
Sulphur	.74

The bituminous coal from the same district is a clean, hard coal, with cubical cleavage, and bears transportation well. That it will serve well as a gas coal, the following analysis will demonstrate:—

Ash	1.60
Carbon	60.60
Sulphur	1.16
Volatile matter	35.44

A very good gas coal, perhaps the best in this district, is mined in the southern part of Scott county. It is said to be similar to the best Pennsylvania coals in general physical characteristics, and to approach them in value in gasification. The coals found in the adjacent county, Anderson, are likewise of excellent quality. Some analyses are submitted to show their general character:—

ANDERSON COUNTY COALS.

	Coal Creek District.	Poplar Creek District.	
Carbon	57.52	60.67	56.120
Volatile matter	38.82	36.53	39.33
Ash	3.09	1.75	2.81
Sulphur	.2	.78	

All of which indicate a first-class gas coal. These coals are supplied principally to the local Southern markets, and are not extensively shipped as gas coals beyond the limits of the State. The greater part of the production of these mines is sold for domestic or steam-raising purposes.

ALABAMA.

Of the Alabama coal we may say, as Cæsar said of Gaul, that it is divided into three parts. Those three parts were originally one whole field, lying in the northern half of the State; but subsequent geological disturbances threw up dividing anticlinal ridges that cut it into three pieces along its southeastern border. These three divisions have been named after the rivers that flow through and drain them, the Warrior, the Cahaba, and the Coosa fields, respectively. The coals contained within them cover an estimated area of 8,660 square miles, and are in numerous seams, of varying thickness. Geologically, the upper coals are of the inter-conglomerate series, and the lower coals of the sub-conglomerate measures. These coal-measures are of astounding thickness, in some places 3,000 feet, and containing 30 or 40 seams, aggregating nearly fifty feet of coal. They are the most southern coals in the United States, and are the terminus of the great Appalachian field, with which we started our inquiries in Pennsylvania, and whose southwestern course we have thus far followed steadily.

Mining was first begun in this State in the Cahaba field in 1853, and the growth of the development is well-nigh incredible. In 1860, only 11,000 tons were mined. In 1870, 30,000; In 1880, 300,000; while 1890 will produce close to the enormous quantity of 4,000,000 tons, placing it fifth in the rank of coal-producing States.

Taking up the various fields, we find the Cahaba lying along

the river of that name, in Bibb, Shelby, and partly in Jefferson and St. Clair counties. The area is 400 miles. The coals are generally semi-bituminous coking coals, running 25 to 30 per cent. in volatile matter, though in some districts the volatile matter rises to 35 per cent. and the coal is reputed to serve as a gas coal. Although it has as many as twelve seams of coal, some two feet six inches thick, the mining is expensive and difficult, on account of the steep dips of the seams, due to the disturbances of the containing measures.

We may say much the same of the Coosa field, lying to the east and northeast of the Cahaba, and having a like area of 400 square miles. Its coals are semi-bituminous, friable, and best suited for coking. The mining of them is likewise difficult, on account of the disturbance of the strata and their irregularity and steep inclinations.

In the great Warrior field, whose area is ten times as large as that of the other two combined, we find the principal deposits of good coals of all bituminous varieties, coking, gas, block, and splint. This field lies principally in Jefferson, Walker, Fayette, Marion, Winston, Cullman, Blount, and Tuscaloosa counties. In Marion, Winston, Cullman, and Fayette counties the seams are generally thin or split up, and unworkable; the coal is of a semi-bituminous character, and is not extensively mined. In Jefferson county is the principal coking region, where the coal for that purpose is taken from the famous Pratt, Black Creek, and New Castle seams, ranging from two feet six inches to four feet six inches in thickness, and furnishing an excellent coke. The coals are too low, however, in volatile matter, to rank as gas coals.

In Tuscaloosa county, while some of the coals, from their analyses, appear to be good gas coals, yet the seams containing them are either, on the one hand, too thin to be cheaply and easily worked, or, when thick, they have slates and clays so interstratified with them as to make it well-nigh impracticable to prepare them properly for the gas coal markets; hence they do not, to any extent, appear there.

In Walker county, the coals are all highly bituminous, of the nature of gas, block or splint. The seams here are horizontal, easy accessible, thick and numerous. There are 35 over 18

inches, and 6 over 4 feet. The larger seams, and that furnishing the gas coal, have the familiar face and butt structure described in the Pennsylvania coals, rendering clean mining easy. We recognize here, though more highly bituminous, the great coking seams of Jefferson county.

The only commercial gas coal, properly speaking, is found in a deposit of area, of, say, 15,000 acres in the southwestern part of Walker county, in what is locally known as the Corona seam. It is mined in the Coal Valley, Cane Creek and Wolf Creek region. The seam runs 3 feet 6 inches to 3 feet 8 inches thick, with one slate parting. The coal is clean, bright, hard, with bright resinous luster, and of sufficient density to bear handling well. It has rectangular cleavage, comes out in cubical blocks, with conchoidal fracture, and resembles very much the Pennsylvania gas coals. In preparation for market, the coal is first "forked" in the mine—*i. e.*, loaded into the mine wagons by forks, with tines three-fourths inch apart, and then outside the mine is dumped over one-fourth inch screen. It is supplied to the local gas companies through the State, and in the adjacent States along the Gulf. The Georgia Pacific and Kansas, Memphis and Birmingham Railroads traverse this region, and are the principal carriers of the coals.

The analyses of the Walker county coals are:

	Corona District.		Coal Valley District.
Carbon................	58.81	50.67	56.60
Volatile matter.........	37.74	41.12	32.67
Ash..................	1.90	7.36	9.41
Sulphur...............	1.94	.42	

	Cane Creek District.	Wolf Creek.
Carbon................	57	58.811
Volatile matter.........	33.78	37.735
Ash..................	6.96	1.953
Sulphur................	.73	

Small streaks of cannel are from time to time found running through these seams of coal, but none of commercial value or importance. The thickest seam is one found in Fayette county, running from 4 inches to 10 inches thick, which, while it is ap-

parently of excellent quality, is, of course, not of a workable thickness.

OHIO.

The coal deposits in Ohio cover an area estimated at some 10,000 square miles. They are in the northwestern portion, and the limit in that direction of the great Appalachian field. They cover the eastern part of the State, running—roughly speaking—from Trumbull county on the north to Scioto county on the south, in a northeast and southwest trend. The measures here correspond directly to those of Pennsylvania, of which they are indeed a direct extension. They are, geologically, divided into two parts, the upper and the lower measures. In the upper, we find the familiar Pittsburgh seam; and in the lower, the equivalents of the Freeport and Kittaning veins of Pennsylvania. The principal seams are numbered from No. 1 to No. 8, beginning at the lowest or Sharon coal, and passing upward to the Pittsburgh. From the westernmost crop, where we find the lowest coal, No. 1, the measures sink towards the east, and expose the successive higher seams as we pass along in that direction, until, in the eastern part of the field, along the West Virginia and Pennsylvania State lines, we find the Pittsburgh seam.

The seams are characterized by regular dip and moderate inclination, permitting of easy and cheap mining. The general dip of the measures is towards the south and southwest, and here, as in Pennsylvania, we find along the general dip gentle folds or undulations, having the same northeast and southwest trend. The bulk of the coal mined in Ohio comes from the lower measures, the Freeport and Kittaning seams, the most important of which is the great No. 6 vein, of the Hocking Valley, the equivalent of the Middle Kittaning.

Ohio's coals are all bituminous, and may be divided into three classes: (1) The dry, open-burning block or furnace coal; (2) the caking or coking coals, which are by far the larger part; and (3) the cannels.

The Ohio Geological Survey, in speaking of the classification of these coals, says: "The division between coking and free-burning coals may be geographically made; generally speaking,

from Perry county, southward, the coal is open-burning; to the northward and eastward it is of the cementing or coking type." This, of course, is a very general statement, as the most famous block coal of Ohio is the Briar Hill, of the Mahoning Valley, in the northeastern part of the State.

The principal use for Ohio coals is for steam. The block coals of the northeastern counties and of the Hocking Valley were largely used in blast furnaces; but the advent of furnace coke from Pennsylvania has nearly, if not quite, driven them out of use. So with the use of her coals for gas manufacture. The coals of Columbiana, Jefferson, Hocking, Meigs, and other counties were originally largely used for gas-making in the numerous gas works that dot the State. But the incursion of the better coals from the adjacent Pennsylvania field, at low rates, has quite driven the Ohio coals into the background. It is doubtful if to-day half a dozen gas works in the State use the native gas coals; and then it will be found to be only where, so to speak, the coal is mined next door to the retort house, and almost shoveled from the mines into the retorts.

The Pittsburgh seam, the principal development of which is along the Ohio River and in Meigs county, depreciates in character and quality as it passes from Pennsylvania into Ohio. The vein thins out, and becomes less clean and pure. The ash and sulphur rise rapidly, and while the volatile matter remains as high as in the best gas coals found in this seam in Pennsylvania, yet neither is the volume of gas distilled found to be as great, nor the quality as good, by many degrees. A section of the coal in Meigs county, near Pomeroy, where perhaps the best gas coal in the State is found, shows a decided inferiority over the same bed as shown in section in Pennsylvania.

An average of analysis of ten coals from ten different mines in this region gives:

Moisture	4.81
Volatile matter	38.60
Carbon	50.05
Ash	6.51
Sulphur	1.42

The next field in importance, as a producer of gas coals, is

the Hocking Valley, which at one time furnished a large quantity for gas making, coming from the great No. 6 seam, or Middle Kittaning. The seam runs from 5 to 12 feet in thickness, but is interstratified with clays and bone coals, necessitating separation in mining, so that the whole depth of the seam cannot be mined out clean. The coal is hard, with bright, resinous luster, holds a moderate amount of mineral charcoal, comes out in cubical blocks, and stands rehandling and transportation exceedingly well. Streaks of cannel are occasionally found running through the upper bench of this seam, which, of course, there greatly enhances the value of the coal in gas-making, but this cannot be relied upon, as the deposit is irregular, changing indefinitely into a shale or horn coal.

Here we find a good lesson as to the value of analyses in the determination of the exact value of gas coals, and, in fact, of any coals. The average analysis of ten of the best Hocking coals gives:

Moisture	5.93
Volatile matter	36.48 to 37.58
Carbon	52.41
Ash	5.13
Sulphur	1.09 to .516

which would, judging from the analysis alone, give a coal that might compete on their own ground with Pennsylvania gas coals; yet the volatile matter, when distilled, gives a yield decidedly inferior in quantity and in quality to that which a Pennsylvania gas coal of same analysis would have produced.

This variation and the reasons for it will, however, be a matter of future consideration, as space for it is not afforded here.

The same considerations apply to the other coals mined in different parts of the State, when used in gas-making. While making a good showing by analysis, they give decidedly poor results in the retorts. Their general characteristics are an unduly high percentage of sulphur and ash, which, of course, affords a very inferior grade of coke. As it is, owing to the proximity of the high grade Pennsylvania gas coals, Ohio may scarcely be said to possess any within her borders. Were her fields, however, more remote from or more inaccessible to the

Pennsylvania deposits, they would be largely drawn upon by her gas companies; for by enriching the native gas coals with the native cannels, which we shall now consider, a good and cheap gas could readily be made.

The Ohio cannels are widely distributed through the State. They appear in the usual pocket deposits. They suddenly replace the bituminous coals in one of the regular seams, and then as suddenly disappear. Their area runs from a few acres in some deposits to 10,000 or 12,000 acres in others. They are principally referable to the lower coals, the Mercer (No. 3) and the Brookville (No. 4).

There is a large deposit in Muskingum county, in the Brush Creek basin, said to be 10 feet thick and to cover a wide area. In Coshocton county, Bedford and Jefferson townships, lies perhaps the largest deposit in the State, from 1 to 6 feet in thickness, and covering an area 12,000 to 13,000 acres. Considerable areas of it are found also in Holmes, Licking, Jackson, Scioto and Mahoning counties. In the last named county it is known as the Canfield cannel, and is considered the equivalent of the Darlington deposit of Pennsylvania.

The Ohio cannels are of small economic value. They are rarely or never developed on their own account, but generally in connection with the mining of some adjacent bituminous coals. They are not high in volatile matter, do not yield a rich gas, and have an excessive quantity of sulphur and ash, which latter averages 12 per cent. They are used locally within the State in gas enriching, and in adjacent States, at points near by. Wherever they meet the Southern cannels of higher grade on competitive grounds, they are generally soon driven from the field. To give a general idea of the composition of these coals a few analyses show the following determinations:

	Coshocton Co. Bedford Cannel.	Jackson Co.	Flint Ridge. Cannel, *Selected.*	Licking Co.
Water	2.35	2.32	3.47	About
Volatile matter	47.05	44.52	43.85	the
Carbon	37	41.13	43 72	same.
Ash	13.60	12.03	8.96	
Sulphur	2.33	.84	.76	

As we turn westward from the Appalachian system we shall find little gas coal, properly so-called, and few deposits that are drawn upon more than locally for that purpose. The Pittsburgh coals are carried out into the far West, and their use at as far distant points as the towns of Iowa, Missouri and Nebraska is conclusive proof of the non-existence in those neighborhoods of native gas coals of much worth. Following the course of Empire, we find next after the Appalachian, the great middle or Illinois coal field, extending over the State of Illinois, and over the western part of the State of Indiana, and the northwestern part of Kentucky. Then next adjacent we find the western coal field of Iowa and Missouri, extending southward into Kansas, Arkansas, Texas, and Indian Territory. In this field lie the westernmost deposits of the Carboniferous period. Towards the Pacific coast the coals in the fields of Colorado, Washington, Wyoming Territory, Dakota, Utah and Oregon are of much later formation, known as the Cretaceous age, and of much higher geological order. They are lignites, or bituminous coals of the lignitic order.

Turning first to the great middle or Illinois coal field, we find we have already considered that portion of it that lies in the northwestern part of Kentucky, so that there remains for our inquiries only those portions lying within the States of Indiana and Illinois. Since there is in those States no gas coal, properly speaking, or any deposits of great importance as a producer of gas coals, it will not be profitable for us to take up the systematic geology of the coal-measures; we shall confine ourselves, therefore, to a few cursory comments upon the general character of the coals.

In Indiana, as in Ohio, we find that the carboniferous measures in the southwestern part of the State contain a great variety of coals, running from a splint or cannel up to a high-grade bituminous. With the exception of the cannel, we find no coals of much economic value as gas coals. Although in analysis many of the coals show excellent composition, their behavior in the retorts disqualifies them from use in gas-making, except to a limited extent. Generally the coke is poor, and the gas yield small in volume and poor in quality. The native coals of Indiana are now little, if at all, used by the gas companies within

her borders. The superior Pittsburgh gas coals, brought at low prices from the adjacent field, have supplanted those native coals that formerly were so used, and it is not likely that a return to them will ever be made. In Daviess county, the coal from the seam known as "K" was once quite extensively carbonized by adjacent gas companies. It is a clean, bright coal, analyzing as follows:

Carbon	60
Ash	4.50
Volatile matter	35.50

which will give a general idea of the character of this coal, which, with other like ones, the advent of the Pittsburgh coal shut out of the gas coal market.

Also in Daviess county is an extensive deposit of cannel, mined from a vein 3 feet 8 inches to 5 feet thick, and of very fair quality. It comes from one of the upper beds of the coal-measures, known as "I," and an analysis determines as follows:

Ash	6 to 20 per cent.
Carbon	40 to 27.473 per cent.
Volatile matter	51 to 50.80 per cent.
Water	3 to 1.29 per cent.

There is also a large deposit of cannel of fair grade in Perry county and local pockets are found at many points throughout the coal regions; none of these, however, have more than local reputation or use.

Almost the whole State of Illinois is underlaid by her coal-measures, which covers an area of some 36,000 square miles, and contain some 15 distinct beds. The available veins are generally of good working thickness, and readily accessible, though for the most part through shafts, owing to the depths at which the best veins lie. The principal centres of operation lie as yet upon the margin of the field, but are being rapidly developed and extended. The annual output is enormous. In 1889, it rose to nearly 12,000,000 tons, placing this State second in the rank of coal producers in the United States. A territory of such great productiveness would seem to merit lengthy consideration at our hands; but it does not. While there is more

native coal used in gasification in Illinois than in Indiana, it is not because the coals are better, but because of their greater remoteness from the Pittsburgh field. The Illinois coals are all of a bituminous nature, and of excellent quality for steam production; but of small value as gas coals. They are for the most part highly charged with moisture, running from 6 to 8 per cent., and also high in sulphur. They are very friable, and liable to disintegrate on long exposure, or in the handling incident to transportation. Those faults alone preclude their use as gas coals to any great extent. The yield of gas is low in quantity and quality, and the coke generally poor, light, and soft. In fact, the use of the native coals is generally confined to those points where they, so to speak, underlie the gas-works, as is true in many cases, and the cost of transportation is reduced to almost nothing. The constantly declining price at which Pittsburgh coal is being offered, is gradually ousting the Illinois coals, and with the further lowering of freight rates from Pennsylvania, we may look for their total exclusion from the gas-coal arena. So far as can be ascertained, no coal is carried from Illinois to any adjacent State for the purpose of gasification.

A few analyses are submitted to show the general character of the coals:—

	Big Muddy District. Jackson County.	Duquoin District. Perry County.	Belleville District. St. Clair County.
Water	6.5	8.5	6.8
Volatile matter	31.2	40.4	33.35
Carbon	60.8	59.6	54.55
Ash	1.5	3	5.9

	Danville, Vermillion County.	La Salle County.	Bloomington.
Water	4	10	7.90
Volatile matter	40.58	27.40	34.02
Carbon	46.78	55	53.12
Ash	8.64	7.60	4.96
		Sulphur	1.97

Leaving out of consideration what is known as the third, or "Michigan" coal-field, which is of small economic value, and

not within the scope of our enquiries, we turn with interest to the fourth, or Western field, representing the western boundaries of the carboniferous measures. Here we find two gas coal-fields of no inconsiderable consequence, each supplying a large adjacent area, and each of wide and well-defined reputation. Kansas and Indian Territory are the two possessors of this distinction, and will command our attention for the most part in considering this field. Iowa, representing the northern portion of the Western field, has within her boundaries no gas coals, and draws, curiously enough, her entire supply from Pennsylvania. Her own coals are high in moisture, sulphur and ash, and of the same general physical character as the Illinois coals. The explanation of the general use of Pittsburgh coals in this State is likely to be that the low through rates bring the Pennsylvania product to her gas-works as cheap as it is laid down at points much farther east. Of Nebraska, it may be said that she has no gas coals, and not much of any other.

Missouri demands more extensive notice. While Kansas and Pennsylvania coals dispute for the gas-coal supply, still some native coals are used, where the deposits are of fair quality, and so near by as to make the cost of transportation low. The coals are all of bituminous character, and the operations are principally found in the western and southwestern counties, adjoining the Kansas field. The most important coal center is in Bates County, where a vein of good workable thickness is found. The seams run from 3½ to 5 feet thick. There is no extended and systematic recent survey of the fields, and little information in regard to them. The coals are, however, not of high grade, being soft, friable, sulphurous, and high in sulphur and ash.

A characteristic analysis is submitted:—

	Lexington Coal, from Fayette County.
Ash	7.71
Carbon	45.32
Volatile matter	36.34
Water	10.63
Sulphur	2.93

There are large deposits of cannel coal in Missouri, lying in large pockets in the Osage River field and along the Missouri River. The principal developments are in Moniteau and Cooper counties. The cannel pockets, which are simply local, irregular, and varying enlargements of the regular bituminous veins of coal are of great thickness at times, running as high as 72 feet. No record of the use or value of this cannel in gasification (or of its physical characteristics or its analysis) has been obtainable.

The coal-fields of Kansas lie in the eastern part of the State, in the counties along the Missouri State lines and extend from Missouri through Kansas into Indian Territory. The thickest and most valuable deposits are found in the Cherokee vein, as it is called, in Crawford and Cherokee counties, in the extreme southeastern part of the State. Here only is the gas coal found. The other coal fields of the State, in Osage and other counties, are characterized by very thin veins, seventeen to twenty inches, of lean, poor coals; and in the center of the State, beyond the boundaries of the coal-field proper, some inferior lignites are developed, but nothing approaching a gas coal has been discovered.

The Cherokee vein crops through the eastern part of Crawford and Cherokee counties, and is in an accessible bed some twenty miles long, in a northeast and southwest line, and of one to two and a half miles wide. The vein dips slightly towards the northwest, while the general containing measures sink rapidly towards the west and southwest, disappearing in the western part of Cherokee county, to rise again in Indian Territory. The workable coal runs from three to three and a half feet thick, though in some places it rises as high as four feet, and is badly cut up by disturbances known as horse backs and clay veins, rendering mining at once expensive and uncertain.

The mines in this district are very large, and well equipped and developed, and the output is quite large. The coal is black and lustrous, with a cubical cleavage, and fairly firm and dense, though it disintegrates rapidly, like most of its western neighbors, upon exposure to the atmosphere.

It is high in sulphur and in ash, but not in water. It may

fairly be said to be a good gas coal, though the high percentage of sulphur and ash are great drawbacks. It yields a fair quantity of gas, of good illuminating power, and the coke is strong and plentiful, say sixty per cent., but, of course, highly sulphurous. The average analyses of nine samples of this coal determined as follows:—

Water	1.94
Volatile matter	36.77
Carbon	52.45
Ash	8.84

The sulphur runs from two and one-half to five per cent. and as high as eight per cent. in some of the coals.

The Cherokee supplies nearly all the Kansas gas companies, and the majority of those of Missouri, but it has a formidable competitor in the Indian Territory coals.

In considering Indian Territory as a gas coal producer, we shall find that the only field lies in what is known as the Choctaw country, which is that portion set apart for the use of the Choctaw Nation of Indians, lying in the southern part of the Territory. From that nation the operators in this district are obliged to secure leases, subject to governmental ratification, before developments may be proceeded with; and from the royalties thus secured a handsome income is had.

The coal-measures are a part and continuation of the great Fourth Field, and an extension westward and southward of the Arkansas, Missouri and Kansas deposits, though they are here found of far greater thickness than in any other part of the field so far as now explored, and show a total depth of some 8,500 feet. Although this region has long been known as a producer of excellent coal, yet particular attention has been recently attracted to it through new and extensive developments that are being made within it. To Mr. H. M. Chance, of Philadelphia, who has conducted the careful and widespread researches into the resources of coal deposits that have led to these new operations, we are indebted for the information in regard to them.

The coal developments are embraced in the region lying between the Missouri, Kansas & Texas Railway and the Arkansas

State line, and we have now to note again, as characteristic of this region, also that the coals toward the east are low in volatile matter, semi-bituminous in character; while as we pass westward, over what are known as the Mitchell and Mayberry basins, we find a gradual increase in volatile matter until we reach the high percentage found in the gas coal of the Grady or McAlester beds. The original operations in this district were at the town of McAlester, on the Missouri, Kansas & Texas Railway, and that town has given its name to the bed principally worked, and in fact to the whole region.

The developments of the best coals are all from veins lying in the lower part of the coal-measures, and are principally confined to two, the McAlester, which is next to the lowest bed in measures; and the "Grady," which is the lowest deposit. The McAlester, the most largely worked bed up to the present time and also the most extensive in area, long ago demonstrated the superiority of its coal over that of adjacent States; but the recent development of the Grady basin has brought to light a coal which, while of the same general character as the McAlester, is of greater and surprising excellence.

These veins run from three and one-half to five feet in thickness, and are generally entirely clean, *i. e.*, free from bone or slate binders. They are mined by drifts near the outcrop, and by slopes or shafts at points further in the basin, where the coal sinks away from the crop line. The coal is bright, clean, and hard; has the luster and general appearance of the Pittsburgh coal. It stands transportation well, and does not disintegrate readily, as might be supposed, upon exposure to atmospheric influence. It possesses a well-defined cubical cleavage, and is interstratified with the mineral charcoal so abundant in the Eastern coals. It is mined in large, clean, cubical lumps, and to the eye of even an expert it might readily pass for the Pittsburgh seam. This is particularly true of coal from the Grady bed. It may, perhaps, be safely said, that here is to be found the best coal west of the Appalachian fields. In its freedom from sulphur, ash, and moisture, in its density, its superior coking qualities, and in its general physical characteristics, it may be said, considering the field from which it is drawn, to be truly a wonderful deposit.

The following analyses confirm the above statements:

	Grady Basin.	Grady Basin.	McAlester Bed.	Grady Bed.
Water	1.792	1.709	1.804	2.478
Volatile matter	40.207	38.668	37.171	37.797
Carbon... ...	51.785	51.482	53.404	55.270
Sulphur.......	1.333	1.006	.896	.950
Ash	4.833	7.135	6.725	3.505

As we leave the district lying at and immediately east of McAlester, the coals deteriorate in quality and rise in impurities, particularly in sulphur and moisture. This McAlester region is now being very rapidly developed, and the badly needed facilities for transportation are being furnished with all possible haste. The coal has found its way to the gas companies of Texas, Arkansas, and Kansas, and no doubt it will rapidly extend its market as more distant ones become accessible.

In gasification, this coal gives a large yield of good gas and excellent coke. In fact, its results approach with surprising closeness those obtained from the standard gas coals of Pennsylvania.

Standing on the western edge of the fourth or Western coalfield, which we have just considered, and looking over the wide area of the western half of the United States, we find that all the coal deposits are of recent formation, comparatively speaking. With the Kansas and Indian Territory fields we have left the coals of the carboniferous measures behind us, for while rocks of the carboniferous era are found further out through the West, they do not contain coal. That which is found in the area under present consideration belongs to the Cretaceous age, and is generally lignite, or coal of lignitic character, heavily charged with moisture and high in ash. To that rule there are some exceptions, notably in the Colorado fields.

What treasures in the shape of gas coal the vast unexplored Wild West may have hidden in the bowels of its hills and mountains, we cannot say. But we can, however, safely predict that it is not likely that any will be found equal to the best gas coals of the East, though some may be discovered that will approach them.

Owing to the lack of development and discovery of native resources, the Pacific Slope draws nearly its entire supply of

gas coal from Australia. Recent increased facilities in transportation, however, have brought the native coals to the front, and no doubt their use will be largely increased in the near future. The principal native source of supply for the Pacific Slope is the State of Washington. The principal coals of this State used in gasification are the "South Prairie" coal, on the Northern Pacific Railway just south of Tacoma, in King County, and the "Roslyn" coal, in Kittitas county.

The "South Prairie" coal is mined from a bed four feet thick. It is soft, rather dull in appearance, and gives seventy to eighty candle feet of gas to the pound carbonized. The coke, while of fair quantity, is poor in quality, soft and light. No analysis of the coal could be had.

The "Roslyn" coal is mined from a vein some five feet thick, covering an area of some twelve thousand acres, and its principal use, so far, as is also the case with the South Prairie coal, has been for steam purposes on the Northern Pacific Railway. Its yield in gas-making and its general physical character are like the South Prairie coal. In analysis it determines:—

Carbon	60.61
Volatile matter	27.72
Water	2.77
Ash	8.80
Sulphur	.10

It is stated, however, that, as the development of these Washington fields proceeds, a better quality of coal is being found, and one which gives more satisfactory comparative results in the retorts.

In Montana, the "Cinnibar" coal, mined in what is known as the Bozeman field, in Madison county, is used in gas-making by the adjacent gas companies in Montana and Washington, with fairly good results. It is described as of medium density, with cubical cleavage, and of fairly clear and bright color. It yields sixty-eight to seventy-five candle feet of gas to the pound, and gives a good quantity of medium quality coke. Detailed information and analyses of the coal of this field could not be had.

Archie C. Wood
Syracuse N.Y.

Colorado affords a striking example of the fertility of a well-developed field, not long ago comparatively unknown. Within her borders we find nearly all grades of coal, from a high bituminous to anthracite, and thence even to graphite.

The State has suffered severe volcanic action, and thus the original bituminous deposits have been carbonized, as it were, into anthracites by the heat evolved by and consequent thereupon. The formations are all of the upper Cretaceous period, but the deposits are of remarkable excellence for that era. Little lignite, which comprises so large a portion of the general cretaceous formation is found; while the coking and anthracite fields together cover an area of some 30,000 square miles. The coal taken from Colorado and used for gas-making, is found in two fields, the Trinidad, near the Raton Mountains in Las Animas county, on the southern border of the State; and in the Crested Butte field, in Gunnison county, near the center of the State.

The Trinidad field covers an area of 750 square miles, and extends to the southward into New Mexico. The main seam worked, known as the Trinidad, is from 6 to 14 feet thick. It has the face and butt cleavage described in the Pittsburgh coals, has a bright bituminous luster, and comes out in large, firm blocks, and does not slack rapidly on exposure. The coal cokes well, and gives in gasification a good yield of fair quality gas, reported as 81 candle feet.

A fair set of analyses gives:

Water	.61	1.26	2.66
Volatile matter	33.18	36.40	36.71
Carbon	57.56	53.10	51.41
Ash	8.65	9.24	9.22
Sulphur	.751	1.11	1.37

which certainly show remarkably low percentages of ash, moisture, and sulphur—always bearing in mind the age of formation of the coal, and the region in which it lies.

Turning to the Crested Butte region, we find ourselves at the famous anthracite formation, which, though a pure, bright, hard coal, is of so small area as to be of small importance commercially for the future. The adjacent deposits of bituminous coal

are not quite equal in quality to those of the Trinidad bed, being softer and more friable. The seam that is worked runs about six feet thick, and is highly charged with fire-damp, making great care necessary in mining. It is a clean, bright, coal, making a firm, compact coke, yielding 60 to 70 per cent. It is reported to give over 80 candle feet of gas to the pound carbonized.

In analyses it determines:

Water	1.17	1.94
Volatile matter	36.80	38.18
Carbon	58.01	56.80
Ash	4.02	3.08
Sulphur	.454	

These determinations disclose here also coals closely allied in their chemical composition and physical characteristics to the best Pennsylvania coals, and approaching them in economic values.

The Colorado fields supply the gas companies of that and adjacent States. So far as can be ascertained by necessarily hasty search, there is no other deposit of coal in the vast Western territory, lying beyond the fourth coal field, where coal is more than locally used in gasification. Here and there are gas companies drawing upon deposits lying, comparatively speaking, at their doors, but disclosing no field of large development or great promise.

It is, however, by no means hence to be argued that such fields do not exist. They may lie as yet undiscovered, awaiting the further growth and development of the country to disclose them. It is, in fact, fair inference to say that they do exist. The results of recent exploration in adjacent regions justify that assertion. And, furthermore, as to whatsoever the Great West may lay claim, who can say it nay?

What thought is uppermost in our minds, after having made this long journey through the coal-fields of our country? What fact remains most persistently before us? What fruit has this search borne to us? This, I take it: that we have discovered a vast deposit of raw material, which merits more than passing consideration at our hands.

We have found in one State alone, a deposit, and that the best, sufficient, rough speaking, for centuries to come. We have found other deposits of approximate excellence scattered through our broad land at convenient distances. The total area of these is almost incalculable; and yet we have looked at only the known and the developed resources. We believe there are as yet undeveloped and unknown resources equally great.

Here, then, is a constant factor in the problem of raw material. Here is a field which we may confidently till. Here is a rock upon which we may safely build the castle of our calculations. What other raw material for the manufacture of gas presents these same advantages? I think we may safely say, there is none.

Two problems present themselves in these considerations. The first is to the miner and vendor of these coals to reduce the cost of their extraction from the earth, and of their transportation to market. The second and greater one is to the gas engineers, to develop the resources and amplify the product of the coal.

In the first task, progress has been rapid of late years, and if not equal, yet continual progress may be looked for in the future.

The better methods and more scientific practice of mining tend to reduce the cost of the coal at the pit mouth. Yet that is in this land of magnificent distances a small factor in final cost. Cost of transportation is the chief element in its determination. And here we may look for the principal reductions. The improved road-beds, the more powerful machines, the more intelligent management of our railways, have already greatly reduced the cost of carrying raw material. And the extension and development of our already enormous railway systems will accomplish much more. In hardly any other line of mechanical engineering is more promised and confidently looked for than in this question of cheap and rapid transportation. The advances of the last ten years speak for themselves; should they be more than duplicated in the next decade which we may confidently hope for, have we not much to expect?

So much for the delivery of the coal at the point of its manipulation. The task of resolving the secret resources, of devel-

oping and determining its possibilities, is a much higher and difficult one. And here we are led to ask whether this task has been wrought upon as it deserves? Has it not to some extent lain neglected? Is the apparatus of the manufacture and resolution of the coal of high mechanical order or great ingenuity of design? Have we not lingered here too long, perhaps, in the ways of our fathers? Have the same ability, energy, enterprise, money and time been devoted to the development of apparatus for the extraction of gas from coal as have characterized the researches and development of other processes of illumination?

Is this because the possibilities of gas coal as a source of production of illuminants have been exhausted? That can hardly be held to be so. Have we reached the Ultima Thule, in our search after the perfection of development? Certainly it does not seem that we have? Who can say that all the energy of the coal has been developed, or that its hidden treasures have been discovered? Is the process of retort distillation to be the last, as it was first, method of extraction of the gas? Is that practice which drags its slow length along, the measure of our abilities and ingenuity? Is there no more rapid, effective, and economical method within reach of our inventive genius? Do we exhaust the coal of its illuminants in our carbonization as at present practiced, or do we pour out and practically throw away into our tar-wells more light-producing elements than we have carried into our holders?

These and a hundred other questions crowd upon us in looking over this field of work. And do they not merit serious consideration?

It is not within the scope of this paper to dwell upon these questions, or to answer them; but it is perhaps within its province to suggest them. The answers lie with the gas engineers; and they, that have committed to them this magnificent task of furnishing light to their fellow-men, must take some thought for the morrow. They must build upon lines of stability and permanence. How high and lasting a superstructure may be erected upon the broad and lasting foundation we have disclosed!*

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*THE APPENDIX—The author desires to acknowledge his indebtedness to the *Geological Survey of Pennsylvania*, with especial reference to the work of

Discussion.

THE PRESIDENT—Gentlemen, you have listened to a very valuable and interesting paper. Mr. Adams and his paper are placed somewhat at a disadvantage here, it being impossible to treat a question of this kind in a paper as short as we ordinarily have presented to the Association. I think each and every one of you will find it advisable to retain a copy of this paper, and not only to read it but to study it. It is a paper that requires absolute study and quiet consideration. Mr. Adams will be glad to answer any questions that you may ask.

MR. A. C. HUMPHREYS—I would like to follow in the line that the president started in on, and to say that I think we ought to try to impress upon Mr. Adams that no discourtesy is intended to him by the absence of members, or by the necessity of skipping portions of the paper. It is of a class of papers that must be carefully read to be appreciated. I think that it would be to our interest in the near future, when the finances will permit, to have the papers printed in advance of each meeting, and distributed to the members, and then they need not be read before us in full, but read by title. We are now depriving ourselves of many valuable papers—or rather of the opportunity of discussing them—by lack of opportunity to study them beforehand. This is certainly a most valuable paper and one that will be useful to us.

MR. ADAMS—I thank you for your kind words, and I present this paper to the Association as a record of what I have done. I hardly think it is a paper that can be discussed in this short time.

Mr. E. V. D'Invilliers; *Kentucky Geological Survey; Alabama Geological Survey; Ohio Geological Survey; Indiana Geological Survey; State University of Kansas; Colorado School of Mines; Officers of the Norfolk & Western Railway; Officers of the Choctaw Coal & Railway Company; Mining Statistics Division of the Census; State Mine Inspectors of West Virginia, of Illinois, and of Kansas; Franklin Institute,* of Philadelphia, Pa.; *A. N. Humphreys,* of Irwin, Pa.; *R. H. Sanders,* of Philadelphia, Pa. Also, to many others for their kind assistance; but finally, and most especially, to the officers of the gas companies of the country for prompt and full replies to the inquiries made of them.

Mr. A. E. Boardman—Mr. President, I agree with yourself and Mr. Humphreys in your estimate of the value of this paper. I would add that I think it is one of the most important papers that has been presented to us, and I believe it will remain as one of the standards for reference, not only by this Association, but by all who are interested in the production, distribution and sale of coal generally. It marks a new departure in the papers presented, read and discussed at these meetings. It is one of the few papers that we have had presented in years which is too great for our consideration at the meeting, but which will become a matter of reference for us in years to come, and will be copied not only in the *Journal*, but will have a life in the future beyond that. None of us would care to discuss the points made or the conclusions stated by an expert in this business. We will have to accept this paper, feeling sure that it has been compiled from reliable sources. I hope that it is the beginning of many more such papers that will take the time and study of members of this Association,—not papers that are ephemeral in their nature, to be disposed of at one meeting, and perhaps never again referred to, but such as will become a permanent record of a valuable literature which will grow up around our profession.

Mr. Littlehales—Can you give us an idea of what is the actual limit of sulphur that you have found in coal? I ask the question because I had a dispute with a member yesterday as to the amount of sulphur that could be found in gas coals.

Mr. Adams—I believe in some gas coals the sulphur runs as high as 5, 6, and 7 per cent. I think Mr. Chollar can bear me out in that assertion, as the Kansas coals probably contain more sulphur than is found in any other sorts.

Mr. Chollar—In reply to that question I cannot say positively what the percentage of sulphur is in some of our Western coals, but I think that the gentleman is about right in saying that it is as high as 6 per cent. It has been so bad that I have frequently appealed to our coal dealers to put a little more coal in with the sulphur.

On motion of Mr. Beal the thanks of the Association were voted to Mr. Adams.

Appointing a Committee of Arrangements.

The President—The Council suggest the following names as the committee of arrangements for the New York meeting: Messrs. W. R. Beal, W. H. Bradley, Eugene Vanderpool, Oscar B. Weber, F. S. Benson and the Secretary. What will you do with that recommendation? (Adopted, on motion of Mr. Boardman.)

The President — The question was raised a while ago whether there would be a meeting of the Council to take into consideration the recommendation of the committee on the President's Address with respect to amendments to the constitution. In looking over the constitution I find that such a meeting is not necessary. If the proposition is suggested at this meeting, the Council may at the next meeting offer it for adoption; and they must do so if requested by five members. It was requested by five members, and the request was ratified by the entire Association; so that they are pretty sure to bring it in at the next meeting. A suggestion was made that we have taken no action relative to the announcement of deceased members. At our Council meeting that question was taken up, and the suggestion was made that it had been customary heretofore to have the proper notices printed in our proceedings, but there was no special action taken at the meeting. That is the reason that the Chair has not suggested that there be a committee appointed. It is an unusual custom with this Association (although it is the custom in other associations), but the Chair is ready to hear any suggestion which may be made upon that point.

The Secretary—I will say that many letters of regret have been sent in, by members unable to attend, but it seems impossible to read them all. Among them are letters from General Hickenlooper, Mr. C. H. Nettleton, Mr. Edward Lindsley and many others, all expressing special reasons for not being present.

The Association then took a recess until 2 P. M.

SECOND DAY—AFTERNOON SESSION.

The Association was called to order at 2 P. M. On motion of Mr. Fodell, seconded by Mr. Harbison, the following resolution was adopted:

That the Committee of Arrangements for the New York meeting be authorized to provide a banquet at that meeting, and to make all proper arrangements therefor; it being understood that the expense be assessed pro rata upon each member attending. The resolution was adopted.

Mr. A. G. Glasgow, of Philadelphia, Pa., then read the following paper on

THE PRACTICAL EFFICIENCY OF AN ILLUMINATING WATER-GAS SETTING.

As a prefatory note, let me state that this paper treats exclusively of water-gas apparatus of the Lowe type,—*i. e.*, where the energy of the generator blast products is utilized in gasifying the enriching oil through the medium of a "superheater."

I will also state that the results given herein all refer to a thousand cubic feet of unpurified carbureted gas, and that the gases are reduced to 60° F.

The secret of fuel economy in the manufacture of water-gas lies in the following apothegms:

Keep the generator fire in a uniformly hot and healthy condition, varying as little as possible from the best temperature for gas production. This necessitates short runs and blows, their relative lengths being determined experimentally.

Never admit an excess of steam.

Always admit a sufficiency of steam.

So adjust the blasts that the generator and superheater shall reach their proper respective heats simultaneously, while

All the oxide produced is being consumed in superheater with

No excess of air.

Keep the superheater bricks clean.

These conditions being fulfilled, as closely as practice per-

mits, have we then reached for all time the highest attainable efficiency?

If not, where shall we look for further improvement?

The desire to answer this last question with accuracy, has led to several weeks of experimental work, some of the results of which are incorporated in the paper about to tax your patience.

The chief aim of these investigations has been to establish an equation, or heat balance, in which there shall be no unknown quantity, the one side representing the fuel consumed in the apparatus, and the other the itemized energy obtained or dissipated therefrom. To this end, the first step was to weigh the total fuel (anthracite coal) fed into generator, and the ash and unconsumed coal recovered—the difference being the total combustible used. This combustible may, without appreciable error, be considered pure carbon, with a heating equivalent of 14,500 British thermal units per pound.

A carefully selected average of results gives, per thousand cubic feet of unpurified carbureted gas:

Table I.

Total anthracite charged	33.4 lbs.
Ash and unconsumed coal recovered	9.9 "
Total carbon consumed	23.5 "

The average composition, weight, and specific heat of the unpurified carbureted gas, the uncarbureted water-gas, the blast products escaping from superheater, and the generator blast gases are recorded below in the order named:

Table II.—Carbureted Gas.

	Composition by Volume.	Weight per 100 Cubic Feet.	Composition by Weight.	Specific Heat.
$CO_2 + H_2S$	3.8	.465842	.09647	.02088
C_nH_{2n}	14.6	1.139968	.23607	.08720
CO	28.0	2.1868	.45285	.11226
CH_4	17.0	.75854	.15710	.09314
H	35.6	.1991464	.04124	.14041
N	1.0	.078596	.01627	.00397
	100.0	4.8288924	1.00000	.45786

Table III.—Uncarbureted Gas.

	Composition by Volume.	Weight per 100 Cubic Feet.	Composition by Weight.	Specific Heat.
CO_2	3.5	.429065	.1019	.02205
CO.	43.4	3.389540	.8051	.19958
H	51.8	.289821	.0688	.23424
N	1.3	.102175	.0242	.00591
	100.0	4.210601	1.0000	.46178

Table IV.—Blast Products Escaping from Superheater.

	Composition by Volume.	Weight per 100 Cubic Feet.	Composition by Weight.	Specific Heat.
CO_2	17.4	2.133066	.2464	.05342
O	3.2	.2856096	.0329	.00718
N.	79.4	6.2405224	.7207	.17585
	100.0	8.6591980	1.0000	.23645

Table V.—Generator Blast Gases.

	Composition by Volume.	Weight per 100 Cubic Feet.	Composition by Weight.	Specific Heat.
CO_2	9.7	1.189123	.1436	.031075
CO.	17.8	1.390180	.1680	.041647
N	72.5	5.698210	.6884	.167970
	100.0	8.277513	1.0000	.240692

Table I gives

$$23.5 \times 14500 = 340750 \text{ heat units}$$

for the energy absorbed by the apparatus. This quantity forms the debit side of our heat balance, and will be designated for the present by the letter "A." Its disposition is as follows:

B, the energy of the CO produced.

C, the energy absorbed in the decomposition of the steam.

D, the difference between the sensible heat of the escaping illuminating gases and that of the entering oil.

E, the heat carried off by the escaping blast products.

F, the heat lost by radiation from the shells.

G, the heat carried away from the shells by convection (air currents.)

H, the heat *rendered latent* in the gasfication of the oil.

I, the sensible heat in the ash and unconsumed coal recovered from the generator.

Our equation, therefore, reads:

$A = B + C + D + E + F + G + H + I$; A being known.

To find B:

It is first necessary to determine the volume of pure water-gas per M; M being always understood to mean a thousand cubic feet of unpurified carbureted gas.

Taking CO as an index, a comparison of Tables II and III shows that $\frac{280}{434}$, or 64.5* per cent. of the volume of the carbureted gas is pure water-gas, distributed as shown in Table VI.

Table VI.

CO_2	2.3	64.5 per cent.
CO	28.0	
H	33.4	
N	.8	

One pound of CO @ 60° F. contains 13.531 cubic feet. The CO per M, therefore, weighs $280 \div 13.531 = 20.694$ lbs. Hence the energy of the CO is

$$B = 20.694 \times 4395.6 = 91043 \text{ heat units.}$$

To determine C, the energy absorbed in the decomposition of the steam:

Table VI shows that 334 cubic feet of H are liberated in the generator, per M of carbureted gas made. A pound of H @ 60° F. contains 189.2 cubic feet, hence

$$334 \div 189.2 = 1.7653 \text{ pounds H.}$$

According to Thomsen, the combustion of a pound of H develops 61524 units of heat. In the experiments under consideration, the steam entered the generator at a temperature of 331° F. We have, therefore, to deduct from Thomsen's figure the total heat required to raise the product of combustion of one pound of H from 75° to 331° F., 75° being about the temperature to which his products were reduced. This gives

$$1140.2 \times 8.98 = 10239 \text{ heat units. Therefore,}$$

*Several runs of uncarbureted gas, made directly into the relief holder, measured 66 per cent. of the average carbureted make.

$61524 - 10239 = 51285$ heat units, is the energy absorbed in the generator per pound of H liberated, and

$$C = 51285 \times 1.7653 = 90533 \text{ heat units.}$$

It now becomes necessary to know the temperatures at which the illuminating gas and blast products leave the superheater, as well as the volume of the blast products. A very brief description of how these determinations were made will suffice.

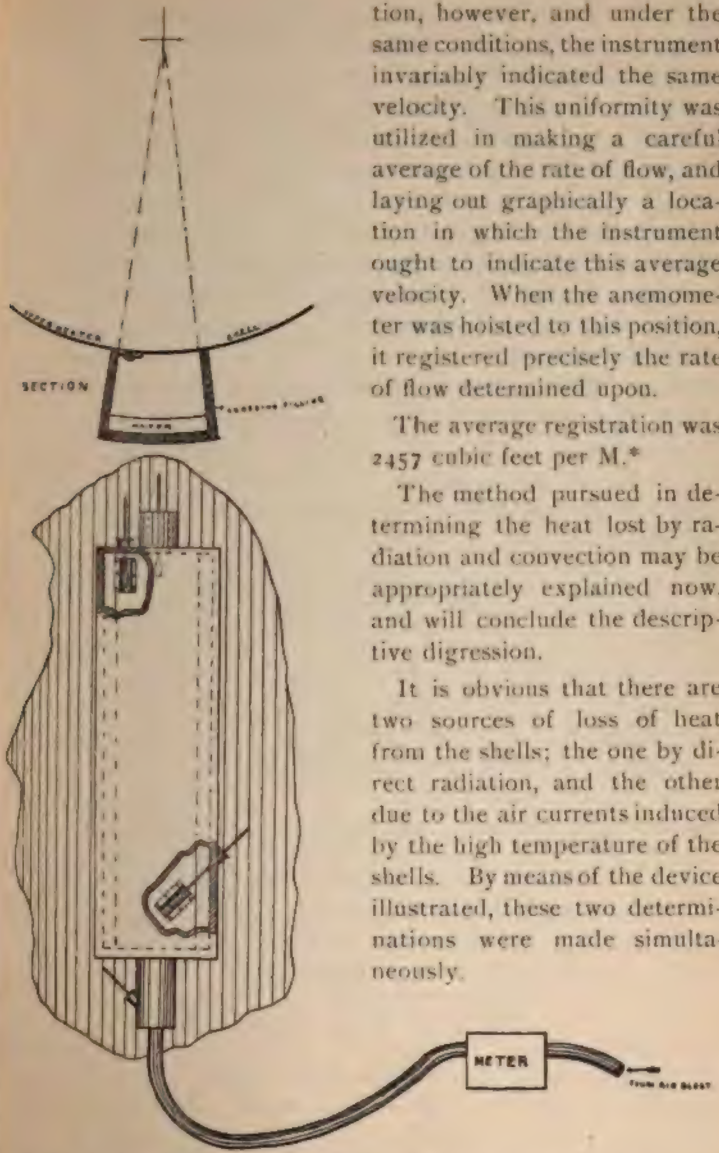
The temperatures were determined by means of copper balls and a calorimeter, every precaution essential to accurate scientific work being observed. In addition, a pyrometer was used to note the variations in temperature of the illuminating gas, its readings being checked by means of the copper balls. Special care was taken that the balls should reach the full temperature of the gas before being removed, that no heat should be lost during transmission from the apparatus to the calorimeter, and that no ebullition should take place when the heated ball was plunged into the water. These latter points were successfully guarded against by enclosing the ball in a small copper cup immediately upon withdrawing it from the superheater, the cup being completely enveloped in a pair of wooden tongs. From the time the ball was withdrawn from the superheater until it was submerged in water averaged about nine seconds.

The average temperatures were:

Table VII.

Illuminating gas..............................	1450° F.
Blast products.............................	1550° F.
The temperature of the oil entering carbureter was...	235° F.
The temperature of the entering blast was..........	76° F.

The blast was measured by an anemometer provided (by the maker) with a special table of corrections. To keep the anemometer from overrunning its limit of speed, a short section of thirty-two-inch pipe was placed in the main line of sixteen-inch blast pipe, and in this the instrument was located on a movable bearing, a glass window enabling it to be read while in place. In spite of carefully-designed baffling plates in either end of the thirty-two-inch section, the rate of flow was found to vary largely with the position of the anemometer. In a given posi-



tion, however, and under the same conditions, the instrument invariably indicated the same velocity. This uniformity was utilized in making a careful average of the rate of flow, and laying out graphically a location in which the instrument ought to indicate this average velocity. When the anemometer was hoisted to this position, it registered precisely the rate of flow determined upon.

The average registration was 2457 cubic feet per M.*

The method pursued in determining the heat lost by radiation and convection may be appropriately explained now, and will conclude the descriptive digression.

It is obvious that there are two sources of loss of heat from the shells; the one by direct radiation, and the other due to the air currents induced by the high temperature of the shells. By means of the device illustrated, these two determinations were made simultaneously.

*Table IV shows an excess of air of 15.2 per cent. of the total air passed through apparatus. It will be interesting to see how this compares with the

The sketch represents the radiometer especially made for this purpose. The back is a water-tank three inches thick, the face of which is copper and heavily lampblacked. The inner sides are of bright tin. The hollow space of one inch between the two casings is filled with asbestos, both on the sides, at the back, and at the top and bottom. The top and bottom are closed, excepting the lower nozzle to which the hose is fastened, and the upper nozzle through which the heated air issues. A thermometer is located in each of these nozzles. When in contact with the shell of the apparatus the radiometer embraces a strip one foot wide and four feet high, making four square feet of radiating surface.

It is evident that when the radiometer is brought into air-tight contact with the shell of the apparatus, the temperature of the enclosed portion of the shell will begin to rise, due to the jacketing action of the instrument. This effect was prevented by passing such a current of air through the radiometer, that the enclosed shell was kept at its ordinary working temperature. In other words, we produced artificially the precise conditions of convection and radiation that prevail in practical working. By metering the air used and observing the initial and final temperatures, the loss due to convection was accurately measured, while the observed rise in temperature of the known weight of water contained in the calorimeter, plus the aqueous equivalent of the latter, gave with equal exactness the loss due to radiation.

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anemometer registration of 2457 cubic feet of air per M of carbureted gas.

The quantity of carbon consumed by this air, is the total combustible, 23.5 pounds, less the carbon that combined with the oxygen of the steam to form (Table VI) 23 parts CO_2 and 280 parts CO.

$23 \div 8.623 = 2.667$ pounds CO_2 and
$280 \div 13.531 = 20.694$ pounds CO.
C in $CO_2 = 2.667 \times \frac{12}{44} = .73$ pounds.
C in $CO = 20.694 \times \frac{12}{28} = 8.87$ pounds.

Total C combined with O of steam = 9.60 pounds.

$23.5 - 9.6 = 13.9$ = total pounds of carbon consumed per M during blast.

$13.9 \times \frac{32}{12} = 37.1$ gives the pounds of O required for its combustion.

$37.1 \times 11.84 \div 20.8 = 2112$ gives the cubic feet of air required for perfect combustion.

$2457 - 2112 = 345$ cubic feet excess; $345 \div 2457 = 14$ per cent. of total air used.

It is a nice problem to determine correctly the temperature of the skin of a heated shell. For this purpose small and very light cups of cast iron were screwed to the shell and filled with mercury, the mercury being in contact with the surface of the shell. A thermometer dipped in the mercury would indicate, within practical limits, the exact temperature of the skin of the shell.

Determinations were made with the radiometer at sixteen different points on the shells—four on the generator, four on the carburetor, and eight on the superheater—two or more tests being made at each point. The average temperature of the water in the radiometer was adjusted to equal that of the wall or surrounding apparatus towards which the portion of the shell measured was radiating. Below is an average of the results obtained in units of heat:

Table VIII.—Loss of Heat by Radiation from Shells.

	Loss per Square Foot of Radiating Surface per 24 Hours.	Total *Revised Radiating Surface in Square Feet.	Total Loss per 24 Hours.	Loss per M (426.2 M per 24 Hours).
Generator . . .	5930	208	1233440	2894
Carburetor . .	4851	293	1421343	3335
Superheater .	5470	485	2652950	6225
			5307733	12454

Table IX.—Heat Lost by Convection.

	Loss per Square Foot of Radiating Surface per 24 Hours.	Total Surface in Square Feet.	Total Loss per 24 Hours.	Loss per M (426.2 M per 24 Hours).
Generator . . .	7216	188.5	1360216	3191
Carburetor . .	6334	346.5	2194731	5149
Superheater .	6000	522.5	3135000	7356
			7689947	15696

*The "neutral" portion, or that part of the shell that radiates to the adjoining shell or shells, has been stricken out, as well as the portion of generator below the grate line.

We are now prepared to determine the remaining items of heat.

Referring to Tables II and VII, we find that the heat lost, due to the escaping illuminating gases, is—

$$D = 48.29 \text{ (weight)} \times .45786 \text{ (sp. ht.)}\dagger \times 1215^{\circ} \text{ (rise in temp.)} = 26864 \text{ heat units.}$$

In the same way, referring to Tables IV and VII, we have, for the heat carried off in a *thousand cubic feet* of the escaping blast products, 86.592 (weight) $\times$ .23645 (sp. ht.) $\times$ 1474° (rise in temp.) = 30180 heat units.

Hence the total heat so carried off is,

$$E = 30180 \times 2.457 = 74152 \text{ heat units.}$$

From Table VIII we see that the loss by radiation is,

$$F = 12454 \text{ heat units,}$$

and Table IX gives us for convection,

$$G = 15696 \text{ heat units.}$$

To determine H, the heat *rendered latent* in the gasification of the oil: This can be found by taking the difference between all the heat fed into the carburetor and superheater, and the total heat dissipated therefrom. It is evident that the excess of the former over the latter will represent the heat rendered latent in the gasification of the oil.

It is first necessary to find the energy contained in the generator blast gases per M of carbureted gas.

Reference to Table IV shows that all the CO in the generator blast gas is consumed in the carburetor and superheater, with an excess of air equal to 15.2 per cent. of the total volume of air used; the volumes of the resulting products being equal to this total volume of air, 2457 cubic feet.

The generator blast gas contains (see Table V) 17.8 per cent. CO.

17.8 parts CO + 42.4 parts air, yield on combustion, 17.8 parts CO_2 + 33.5 parts N, increasing the volume of generator blast gas to 133.5 parts.

Adding the excess of air, we have $1.335 + .848 = 1.575$ for the relative volume of the final blast products.

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† The specific heat of the entering oil is approximately that of the issuing gas.

Hence, $2457 \div 1.575 = 1560$ cubic feet, is the volume of the generator blast gases per M.

$1560 \times .178 = 277.68$ cubic feet CO per M.

$277.68 \div 13.531 = 20.5$ pounds CO per M.

$20.5 \times 4395.6 = 90110$ units of heat generated per M by the combustion of the generator blast gases.

To obtain the total energy fed into carbureter and superheater, the sensible heat in the above gas must be added to this figure. This we find from Table V to be

$$82.775 \times .2407 \times 1.560 \times 1474^{\circ *} = 45812,$$

making the total energy sought

$$90110 + 45812 = 135922 \text{ units of heat.}$$

This energy is disposed as follows:

D, the difference between the sensible heat in the escaping illuminating gases and the entering oil.

E, the heat carried off by the escaping blast products.

F′, the heat lost by radiation from the *carbureter* and *superheater*.

G′, the heat carried away from the *carbureter* and *superheater* by convection.

H, the heat *rendered latent* in the gasification of the oil.

Hence,

$H = 135922 - (D + E + F' + G')$

$= 135922 - (26864 + 74152 + 9560 + 12505)$

$\dagger = 12841$ units of heat.

The sensible heat in the ash and unconsumed coal is

$I = 9.9 \times 1500^{\circ} \times .25$ (sp. ht.) $= 3712$ heat units.

This completes the heat determinations of which the following table is a

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*This temperature was not determined, but is assumed to be the same as that of the blast products escaping from superheater.

†This includes also the heat carried off in the vapors that condense to tar.

Résumé — Distribution of Energy per M.

	Pounds.	Heat Units.
Anthracite coal fed into generator...........	33.4	....
Ash and unconsumed coal recovered.........	9.9	....
A, total combustible (carbon)	23.5	340750
B, the energy of the CO produced..... . ..	6.280	91043
C, the energy absorbed in the decomposition of the steam	6.243	90533
D, the difference between the sensible heat of the escaping illuminating gas and the entering oil	1.852	26864
E, the heat carried off by the escaping blast products..........	5.115	74152
F, the heat lost by radiation from the shells...	.858	12454
G, the heat carried away from the shells by "convection" (air currents).	1.082	15696
H, the heat *rendered latent* in the gasification of the oil	.886	12841
I, the sensible heat in the ash and unconsumed coal recovered..........	.256	3712
Total energy accounted for.	22.572	327295
Unaccounted for (4 per cent).......	.928	13455

Air used per M, in cubic feet	2457
Candle power	31
Gallons of oil per M	5
Candles per gallon	6.2
Specific gravity(calculated)	.6355

The energy accounted for may be divided into

$$\left.\begin{array}{ll}\text{Energy utilized} \ldots\ldots & 13.409 \\ \text{Energy wasted} \ldots\ldots & 9.163\end{array}\right\}\text{pounds.}$$

Considering the total unaccounted-for energy as utilized, there is a waste of $\frac{9163}{23500}$ or 39 per cent. of total combustible, and the absolute efficiency of the apparatus considered as a heat machine is $\frac{14337}{23500}$ or 61 per cent.

The *commercial* efficiency, or the efficiency of the apparatus regarded as a producer of a finished product, is influenced by an additional function,—namely, the percentage of the total oil consumed that is utilized by conversion into gas.

In the above experiments five gallons, or thirty-five pounds

of crude petroleum were fed into the carbureter per thousand cubic feet of gas made.

Deducting five pounds for tar recovered, leaves thirty pounds of petroleum, or

$$30 \times 20000 = 600000 \text{ units of heat}$$

to be accounted for per M.

The heating power, per M, of the carbureted gas is

CO_2	38.0	
C_3H_6*	$146.0 \times .117220 \times 21222.0 =$	363200
CO	$280.0 \times .078100 \times 4395.6 =$	96120
CH_4	$170.0 \times .044620 \times 24021.0 =$	182210
H	$356.0 \times .005594 \times 61524.0 =$	122520
N	10.0	
	1000.0	764050

The heating power of a thousand cubic feet of uncarbureted gas is

CO_2	35.0	
CO	$434.0 \times .078100 \times 4395.6 =$	148991
H	$518.0 \times .005594 \times 61524.0 =$	178277
N	13.0	
	1000.0	327268

Since 64.5 per cent., by volume, of the carbureted gas is pure water-gas,

$$764050 - 327268 \times .645 = 553000 \text{ heat units,}$$

represents the energy of the oil converted into gas, the unaccounted for difference of 47000 heat units being 8 per cent. of the total. This discrepancy I shall not at present attempt to explain, beyond stating that it is probably due to overestimating the heating value of the oil, and not recovering all the vapors condensed to tar and oil.

The commercial efficiency of the apparatus—*i. e.*, the ratio of

*The heating value of the illuminants $C_n H_{2n}$ is assumed to equal that of $C_3 H_6$. In the former determinations of density and specific heat $C_2 H_4$ was taken. As no determinations were made of the individual hydro-carbons present, this is, in both cases, purely an assumption.

the energy contained in the finished product to the total energy (coal and oil) introduced—is therefore 81 per cent.

The writer apologizes for the crude shape in which the above results have been submitted to you, and realizes that he has scarcely opened a very broad subject. He hopes, however, to be able in the near future, to follow it out to a profitable conclusion.

Discussion.

THE PRESIDENT—Gentlemen, you have heard another very interesting and valuable paper, and if I could not have procured a copy of this paper in any other way I would have been perfectly willing to pay the entire cost of coming to this meeting to have the data which he has furnished us. I shall not take up your time. Mr. Glasgow is prepared to answer any question that anyone is inclined to ask.

MR. FORSTALL—This is a paper that ought to be studied over for three of four months before we can really understand it. A very good plan would be to see what is the total theoretical quantity of carbon actually necessary to produce 1,000 cubic feet of gas, without taking into account any losses by convection and radiation, or the heat of the escaping gases. That would show us what we might hope to save by improved design in the apparatus. Beyond that, of course, we could not go. To do that I have figured on the analyses of water gas I already have, to see how much of the total carbon is represented in the water gas, and how much is actually necessary to raise sufficient heat to decompose the amount of hydrogen that was present in the gas. I did that in two ways. I first took it, taking the conditions that actually existed in the machine, where, owing to the depth of fuel necessary to produce good water gas, we are not able to burn the carbon used up entirely to carbonic acid, but must convert a large part into carbonic oxide. Then I also did it by taking the carbon as entirely converted into carbonic acid, getting up the heat for gasifying oil in some other way. I had no data for the first case, and had to wait until Mr. Glasgow's paper gave them to me. My results were that for my analysis we had in the water gas 9.11 pounds

of carbon. If we converted the carbon, in the proportions usually present, into carbonic oxide and carbonic acid, we would need 11.2 pounds to decompose the steam, which would give us 20.31 pounds of carbon to be used in the generator. So that in that regard the only gain left to us would be 3 pounds of the total amount of carbon used in the generator. Assuming that we convert the carbon into carbonic acid, we would have 9.11 pounds in water gas, we would need 4 pounds to raise the heat necessary to decompose the hydrogen, and we would need 0.793 pounds to gasify the oil, or a total of 13.9 pounds. So that if we could save all the heat lost to the illuminating gas by convection and radiation, we would have a saving of about 9 pounds. I think that is all we can possibly get.

Mr. Norris—The assumption that the specific heat of oil gas is practically the same as that of the oil, I think introduces a slight error. Take the case of water. The specific heat in the form of liquid is 1 while in the form of gas, if I recollect rightly, it is about .48. The point that I want to bring up, however, is that of the analyses. The analyses of blast gases have bothered me a great deal. I cannot make them check; whereas these check very well. All the oxygen appearing in these blast gases must come from the air which is introduced. The nitrogen in the analyses gives us a way of finding out how much oxygen has been supplied. That is the debit side of the calculation. The credit side would be the oxygen in the carbonic oxide and the carbonic acid. As I said, these analyses figure up pretty closely; but we are constantly seeing analyses of producer or blast gases which do not so check up. I would like to get some information from Mr. Glasgow, and from members, as to what their experience has been in this direction. I see, in "McGregor, on the Gas Engine" an analysis of blast gas which gives a discrepancy in the proportion of 12 parts of oxygen supplied to 5 parts accounted for. In other words there seems to be a disappearance of the oxygen. The question is, what becomes of that oxygen. In working up a paper of this sort correct analyses are very important, and the way to get these analyses is what bothers me. I would like to ask whether anyone who has had occasion to make these analyses

has figured them up in this way to see if they will check; and if they do check, what system of analysis they used. The one that I have used has been the Hempel, and there is always too much oxygen, or too little nitrogen, whichever way we look at it. Mr. Glasgow has either been more fortunate or more skillful.

MR. SOMERVILLE—I agree with you that Mr. Glasgow deserves the very highest credit for this paper. I would like to ask Mr. Glasgow if I understood him to say that the heat of the machine in practice gave 61 per cent. of theoretical efficiency; or that 61 per cent. was the practical result arrived at.

MR. GLASGOW—If the President will permit me I will try to answer these questions before I forget them. I said that 61 per cent. was the practical efficiency of the apparatus considered as a heating machine, and not as a manufacturer of a salable product. What I mean by that is that 61 per cent. of the total combustible consumed in the generator was utilized. Mr. Forstall points it out correctly when he says that we can save 9 pounds of fuel. The energy accounted for may be divided into the energy utilized, 15.215 pounds, and energy wasted 9.163 pounds. In reply to Mr. Norris' last statement I will say that I can entirely sympathize with him in his suggestion of the disappearance of the oxygen. I have had trouble in that way myself. These analyses are not the actual average of all the analyses I made, but they are the selected average. That is, I have presented here what I believe to be the facts; and when I made analyses that I had reason to believe were incorrect, I excluded them. I believe the trouble is not so much in the awkardness of manipulation as it is in the absorption of carbonic acid when you collect and analyze the gas over water. Mr. Norris asked me a question in the beginning that I do not recall at the moment.

MR. NORRIS—The assumption as to specific heat.

MR. GLASGOW—The assumption is not that the specific heats are identical, but that their difference is immaterial. The specific heat of the gas I have determined here to be .45786; the specific heat of petroleum from the best authorities I can

get (and which I do not vouch for) is .434. That is a very small difference; and so I have excluded it as not worth treating. Mr. Forstall certainly arrives at just the same conclusions I have here; that is, that there is a possibility of saving 9 pounds by saving all losses. In other words, the ultimate goal that we may strive for, but never hope to attain, is a consumption of 13.215 pounds of carbon per 1,000 cubic feet of gas. In reply to Mr. Somerville's question, I would further say that what I have reported, 61 per cent. as the efficiency of the machine, must be understood as relating to the combustible consumed, and not to the coal shoveled in. I used 33.4 pounds of anthracite per 1,000, and only consumed 23.5. Everyone will see that here is the real chance for economy; that is, to get some kind of grate that will not allow as much coal to escape with ash. Of course you can recover some of this cinder by screening; but there the incident of labor comes in, which makes it questionable whether it is worth while or not.

Mr. Forstall—With reference to the unconsumed coal, I think it does pay to screen it. A man can screen out per day enough to make his wages, and make the coal that you recover cost only one-third that of the original coal that you put in, and I have never been able to find but that that coal was just as good after it has been screened as it was when first put into the machine.

Mr. Rusby—I am very much pleased to see this paper come out. I feel confident that not only does it contain information which has never before been put in this condensed form, but a great deal of it has been matter of conjecture altogether. As this experimental work has given us figures on which we can rely in our own works it is of very great value to us. The thing which will interest most of us specially is the outcome, and the amounts of heat lost in various ways. I call attention to the fact that the loss in the blast gases coming out of the stack is greater than all other sources of loss combined. As Mr. Forstall and Mr. Glasgow have mentioned, there is only a possible saving of some 9 pounds of coal; but it leads us up to one subject, and that is the heating of our blast, which ought to be done with the heat of the waste gases. And although we may

not save a very large per cent. of the heat that these contain, yet I think that there is also an incidental saving, which will be considerable, in the increased capacity of the set, and possibly an incidental economy in enabling us to use our fuel better. Between 20 and 25 per cent. of the total heat goes out with the blast gases, and if we can recover one-half of that it is quite an item. Besides there are the incidental economies, which it seems reasonable would be considerable, in increasing the capacity of the set, and in utilizing the fuel that is put in.

MR. CHOLLAR—It seems to me that this Association has never before had presented to it such a mass of statistics in so small a compass; and I feel that it is utterly impossible in any discussion which can be brought out here extemporaneously to begin to do justice to the subject, or to the writer. The paper will be as valuable—and more so—ten years from now as it is to-day. I move that a real and earnest vote of thanks be given to the writer.

MR. BOARDMAN—I second the motion of Mr. Chollar, and I do so with very great pleasure. I have looked around upon the members here present, and I have felt with them and for them. I am glad to see that the younger members of this Association are taking an interest and a stand which is theirs by right of education, and by right of the experience that has been bequeathed to them, and which they are carrying on to higher results than any others of us have attained. I mean in the scientific analyses of our business. I have looked around upon this assemblage during the reading of this paper, and since the discussion began, and I have noticed that none of the old stagers have had much to say. The discussion has been carried on by the younger men; and I am glad to see it. Even the President did not stop a very earnest discussion of this paper between the members for fear they were getting ahead of him in the discussion of the paper; and Mr. Chollar gave it up—for I saw him put up his glasses, as much as to say, "I have got to study this thing more." Gentlemen, this is a hopeful sign. In seconding the motion of Mr. Chollar I feel humiliated that in the busy conflicts of this world in amassing wealth, in striving to attain the mighty dollar, I, and many of the older members

of the Association, have not kept up with the progress of the times. I welcome this paper, and I wish to encourage every member who will give such a paper to the Association, as the earnest of a brighter day for our Association, when the ultimate analyses of our profession shall be as trite in our discussions here as is the subject of naphthaline. (Applause.)

MR. HARPER—I do not wish to take any further part in the discussion of this paper than to say that I had occasion to see most of this work of Mr. Glasgow as it was carried on from day to day; and I wish simply to say that I can vouch for the conscientious way in which the whole of this work has been done. I think so far as the figures can be made reliable Mr. Glasgow has made them so.

THE PRESIDENT—Before putting the question I would like to ask Mr. Glasgow whether the piece of 30-inch pipe which was introduced into the 15-inch for the purpose of starting up the current was of a conical shape, or whether there was not an abrupt enlargement.

MR. HARBISON—Before that question is answered may I ask whether I understood the President correctly as stating that a 30-inch pipe was inserted into a 15-inch? (Laughter.) That is the way I understood his question.

THE PRESIDENT—That question is from one of the *older* members. (Laughter.)

MR GLASGOW—In reply to the President's question, I will say that this 32-inch pipe was about 6½ feet long from end to end; it was cylindrical for about 4 feet of its central portion and shaped off conically at the ends. About 6 inches from each side, where the cone cut the cylinder, a diaphragm was put in, which was simply drilled with 2-inch holes distributed so that the aggregate would be equal to a cross-section of 18-inch pipe, and distributed so as to throw the blast out towards the side. I was amazed to find that after having such a plate, both fore and aft, the blast was not distributed. It was extemely local. It was three times as fast in some places as in others. In determining this average we laid out a life-size plan, and noted the speed as determined by this anemometer in different places of the section, and

this we did every day, always preserving the conditions to the closest possible limit of the previous day's work. We averaged it all and divided up the section, giving each portion its speed, and determined upon a place where it ought to indicate average speed. On putting the anemometer into this place we found that it indicated precisely that speed. In reply to Mr. Forstall's remarks about the ash, I do not want to go on record as not encouraging the screening of cinders from hard coal; but I have found that in the use of the Kansas coke the game was not worth the candle. However, this coke burns up cleaner than coal. We ran on 30½ of coke, where we had been using 33½ of anthracite coal—the amount of combustible being the same—so that the difference is in the screenage. I thank you, Mr. President and gentlemen, for your very courteous reception of this paper.

THE PRESIDENT—I asked the question because I had had considerable experience in the use of the anemometer in connection with natural gas; and in my earlier experience I noticed that unless the pipe was enlarged conically so as to take up about the position that the gas would take in expanding on coming out of the pipe, it was very difficult to get anything like accurate measurements through an anemometer. By having the cylinder conical we got very accurate results. You have heard the motion to give a hearty and earnest vote of thanks to Mr. Glasgow for his paper. [Adopted.]

AN EXPLANATION IN RESPECT TO THE COMMITTEE ON WORLD'S FAIR.

MR. HARBISON—The honored President of this Association, Mr. McMillin, during the year went to Europe, and during his absence it devolved upon me, as First Vice-President to call together the World's Fair Committee, and to have somewhat an active part in the formation of that Committee, by consultation and advice with those who are interested in the matter. The President in his Address referred to the fact that the industries connected with our profession have been apparently overlooked in the selection of the personnel of the World's Fair Committee, as appointed by the various Associations, and

that he thought it was an oversight and a mistake. Your Committee on the President's Address has recommended, and you have adopted the recommendations, that the Council take note of that, thinking it was an oversight on their part. I desire to say, if you will permit me, that it was designedly so, and only after careful consultation with various gentlemen engaged in the industries connected with our profession; and for this reason: It was impossible to put on a Committee that would be efficient, a representative of every manufacturing concern in the country of gas stoves, gas engines, gas works supplies, and everything of that kind—all of whom we hope will come forward and make an elegant display. We thought if we made a selection from amongst the number jealousies would at once crop out. And so, in consultation with representative men in the various industries, after making the suggestion to them, they said, "You are right. Put no one on the World's Fair Committee that is engaged in the manufacture of any supply for the gas profession. Then all will be treated alike, and your exhibition will be a success." In naming the personnel of the various committees representing the various Associations, one further matter was kept carefully in view, namely, that we wanted to keep down the expense attending the work of this Committee to the lowest possible dime. Hence you will find, if you look over the personnel of the various members of that Committee, that some are named by some 2 or 3 different Associations, so that you need not have too large a number in numerical strength. They did not propose that this Committee should be a junketing affair, to travel over the United States, for their own pleasure, at the expense of the Associations, but that they should do the work without compensation, the Associations paying only what was absolutely necessary for actual expenses. The Committee do not propose (and I know that I voice the sentiment of every member that has been named) to have the Committee as a Committee, with all the members present, to attend to the detailed work, but to appoint executives, or subcommittees to whom shall be delegated the various duties to be performed, so as to keep the work of that committee down to the lowest possible item of expense. It appears to me, Mr. President and gentlemen, that your Committee (with perhaps

the one single exception on it) is the best selection you could have made; and I think it would be a mistake to have any change made in the present arrangement of that Committee. Your Committee is large enough. The duties will be confined principally, I apprehend, first of all, to get sufficient space from the World's Fair Committee in Chicago for a gas exhibit, and seeing that the gas industries are well located in the building; and then to interest manufacturers in bringing their exhibits to the fair. I apprehend that those will be the duties of your committee, and those only. I say this much by way of explanation, and in behalf of the Council to whom you have referred portions of the President's Address, so that if they did not take any action you will understand the reason why. If you have any orders to give in connection with the matter I have no doubt your Committee will strictly obey them.

The Secretary read the following telegrams:

"TORONTO, October 16th, 1890.

"C. J. R. HUMPHREYS, *Secretary*:—Please convey my sincere thanks to the Association for the honor done me in electing me Vice-President. Much regret my inability to attend the meeting.

W. H. PEARSON."

"*To the President of the American Gas Light Association:*

"SAVANNAH, GA.

"DEAR SIR:—I am instructed by the Board of Directors to extend to the officers and members of your Association and the ladies accompanying them, the privileges of the Savannah Cotton Exchange during their stay in the city.

Very respectfully,

J. B. MERIDAN, *Supt.*

On motion of Mr. Harbison the invitation was accepted with the thanks of the Association.

The PRESIDENT—Perhaps you have not known about it, but there is a wonderfully fine exhibit of gas burners, gas stoves, and gas appliances of all kinds in the basement at the corner of this building. By accident I found it myself; and I think that

the gentleman who arranged the exhibit ought to be reprimanded for not having made it known before this time.

Mr. A. E. Boardman, of Macon, Ga., then read his paper entitled

HINTS ON ELECTRIC LIGHTING BY SMALL GAS COMPANIES.

"Once upon a time" the *London Punch* was asked advice by a young man about to be married. With that admixture of wisdom and drollery which characterized him, he summed up a world of warning, which he was perfectly well aware would not be heeded, in the single word, "*Don't.*"

So, with equal seriousness, and with equal certainty that my advice will not be taken, I give my first *hint* to small gas companies about to engage in electric lighting. It is contained in the single word, "*Don't.*"

This doubtless seems a radical departure from the position which I have hitherto maintained in the discussions on this subject before this Association, and demands a word of explanation. It is not so much a new departure as a change of front made necessary by fuller knowledge. As our eminent Secretary of State explains his reciprocity scheme to be, not a step in the direction of free trade, but a logical and natural outgrowth of the principles of protection, derived from experience, and carried to its fullest extent; so the warning I would give in regard to electric lighting is the natural outgrowth of the experience I have had in following the course that I have heretofore recommended, namely, to consolidate the two lighting systems under one management. All that has been said of the advantages to be derived in the lessening of salaries, office expenses, etc., by having the gas and electric works under one management, is true. It is also true that a gas company can afford to generate, distribute, and sell electric light cheaper than an electric company doing *only* that business.

But it is not true that, *therefore*, the gas company will make more money by undertaking the electric lighting than by not undertaking it.

To say that *no* money can or will be made by the gas com-

pany in electric lighting would be untrue, for, in many cases, fair profits are realized; but if the same amount of money that is necessary to equip an electric station and construct circuits were devoted to improving the gas plant and extending and enlarging mains, greater profits could and would be made in the long run.

Those of you who have recently talked with agents of the various electric lighting systems, and have carefully figured with them on the cost of installing and operating an electric light plant, making the usual large allowance for incidental expenses and repairs, will be inclined to question this statement.

Those of you who have been in charge of a station, and have collected the rents and paid the operating expenses for a year or two, will probably have a suspicion that there is some truth contained therein.

One reason why electric lighting does not pay as well as we are led to expect is, that we are charged entirely too much for the apparatus in the first place, and the same extortion is practiced upon us throughout for material needed in operation and repairs. Enormous profits are made by the electric companies on all the electric appliances entering into the business, and these profits are taken out of the capital invested by the local operating companies and their earnings.

Another reason is that mishaps frequently occur, through freaks of the electric current entirely beyond our control or knowledge, and from lightning strokes and short circuits, often entailing expensive repairs, if we are fortunate enough to escape damages through the courts. These are never calculated upon, because there is no reliable data on which to base calculations; still, they always happen more or less often.

Again, an electric plant pays best when the total number of lights for which it was built are in use; any less number makes the capital invested, the labor and superintendence too great for the most economical working. That is the point we strive to reach, and when accomplished, we find it a very distressing position. If one or two more lights are demanded, we must either lower the candle power of all in use, erect more machinery, or refuse the demand. If we try the first plan, there is a very general kick; if the second is determined upon, we

place ourselves back to a less economical working point; and if the last is resorted to, another electric company is promptly invited to partake of our "pie."

As the first hint given you will certainly not be taken, since the circumstances governing each case are different, and they determine the question of whether you will or will not engage in electric lighting, the other hints are in order.

In the first place purchase your electric machinery and appliances of the best and most reliable manufacturers. Of course, I could tell you where and of whom, but that is professional knowledge which would require some consideration before it could be disclosed. In contracting for it the best practice is, probably, to have the electric company furnishing the plant to erect it and turn it over complete, and after a month's working test. This obviates any question arising as to where the blame attaches, should anything go wrong. Much trouble and expense will sometimes be saved if your contract states that when finished, the entire plant shall be inspected by the expert employed by the insurance association of your district, and that it shall be made to comply with the requirements of the board of underwriters and city authorities. The most reliable company, with every desire to erect you the most complete and thorough work, has to depend upon workmen who are not always as careful as they should be, and a thorough inspection of every part of the plant by a competent and impartial expert is absolutely necessary. As the insurance board will demand your compliance with their rules, their expert is a suitable one to say when the plant is properly installed. Besides, the fact of his having passed upon it would have strong bearing upon the question of liability for damages caused by imperfect connections, should it be brought before the courts.

Another thing that is well to have embodied in the contract is your right to use any and all of the patented appliances purchased in connection with the plant, and that you be protected in said use from costs and damages through suits brought by others claiming such right.

In your talks on the subject with the agent of the electric company which you have selected to close your contract with, you will have become convinced that a high-speed engine with

direct belting is, on the whole, the best power for you to purchase; both on account of the economy of first cost and the compactness of the plant. Also, as obviating the extra friction of the countershafting and increased liability of slipping belts, and wear and tear of the same. You may have started into the matter with conviction, based upon theory, that the cheapest power, in the long run, is the comparatively slow-speed engine with countershaft, from which can be belted one or more dynamos. You may even have studied the subject some, and read reports from American and English sources, as to the best practice. In both you will find different opinions, and while the English practice is mostly with the countershaft, they acknowledge that in the "States" many are successful with the use of direct belting on high-speed engines.

The general practice in this country has been with this class of engines, and it is in this country where electric lighting has made the greatest advances, and is more generally used. Therefore, it will be argued, the direct belting on high-speed engines *must be* the best. And so many instances of this kind of plant will be quoted, that you will hardly dare to put your judgment, based on theory, against the general verdict. Especially will this be the case if you are a *modest* man, as are most gas men. Right here I will give you another important *hint*. If you have about concluded to install a high speed engine and direct belting, the advice of *Punch*, before quoted, is again applicable—"*Don't.*"

The advice of the electrical agent is all right from his standpoint. In order to induce your Board of Directors to purchase an electric plant at all, it is necessary to make the first cost as little as possible; and since the price of the electrical machinery must not be scaled, in justice to his employer, the lowest priced steam plant must be recommended. And since many others have used it with success, why not recommend it? He may tell you, and with entire truth, that it does not matter to him what system of power you use, and that if he is to supply it, he will charge you only the net amount that it costs him. That may be so, still the bias is there toward the lower cost for power, so the large cost of the electric apparatus will not make so great an impression when the total price of the plant is considered.

Now I am not up here as a target for the advocates of high-speed engines to fire at, nor am I employed to advocate the use of the other class. I am only giving *hints* derived from personal experience. I may have been unfortunate in getting the worst engines of the particular make, or in being incompetent myself to manage a high-speed engine, or have depended upon careless and incapable engine men; be that as it may, the high-speed engines that I have used, from three different and highly recommended makers, have proven quite expensive to operate and maintain; and in two stations I have substituted the slower speed engines with countershafts, and with very gratifying results. The high-speed engine giving the most satisfactory service, under my observation, is one furnishing the power to operate a street car line, where the load is constantly varying, between wide limits, and in such a case, the prompt and efficient automatic governor, regulating the speed to a nicety, is of very great value. Even here, I believe, economy of fuel and repairs would be greatly on the side of a slower engine with countershaft.

Having spoken so often of high and low-speed engines, it might be well to explain what is meant by the two terms. It is not necessary to go into an elaborate definition, but it will answer our present purpose to consider the high-speed engine to be one making say 180 revolutions per minute; and the slow-speed engine as making about half that number per minute. The piston speed in feet per second may in both cases be the same. Should that be the case, the diameter of the cylinder in engines of equal power would be the same; but the length of cylinder, and therefore of stroke in the low-speed engine would be double that of the high-speed engine, and the number of strokes, and hence of changes in direction of all the moving parts, of the latter will be twice as many as in the former. It is this frequent change of direction, as well as the additional liability to hot journals, in the more rapidly revolving main shaft and crank pin that causes much of the extra expense in operating the high-speed engine.

It may be argued that the cut-off remaining say at one-quarter of the stroke in both instances, the amount of steam used will be the same, whether in the cylinder of 18 inches in length

or that of 9 inches. It certainly would seem so. However, I am convinced that more steam will be used, in practice, to develop the same power in the high-speed engine. The exact proportion I am unable to state. One reason why this is so, I presume, is because double the amount of inertia is developed in the high-speed engine, consequent upon doubling the number of changes in direction of the moving parts; and this inertia is developed at the cost of the power. The wear upon connecting rod and main shaft, journals, crank pin and brasses, and main pillar blocks is also doubled, since the knock, if one occurs, be it ever so slight, is twice as often and the corresponding jar to the entire engine is twice as frequent. More oil, and that, too, of a better quality and higher price is necessary. The stoppages of the engine and consequent interruption in the light are also much more frequent, and this is a matter which causes more gray hair on the manager and more profanity in the community than any of the other evils mentioned. If my trouble resulted from slack management and incapable help, many of my hearers are liable to be similarly unfortunate, for the Superintendent cannot always be present, and engine men are "pretty much of a muchness."

Beware of the insulation around your main wires, and for that matter, around all your wires. When I had absorbed all the information which my friend, the electric agent, could or would supply, and had read the glowing descriptions of the various insulated wire manufacturers, each one making the best, I came to the conclusion that the safest to use was "Underwriters" wire. That surely must be all right, for the name indicated that it would satisfy the insurance men, and the records showed that more of that kind was in use than of any other. Besides, it was quite cheap as compared with the "Okonite" and such. In my stupid ignorance I did not dream that the name was due to the fact that it was about the only kind of covered wire, claiming to be insulated, that the *Underwriters* objected to. It's all right *inside* of a building when thoroughly protected from rain, steam, dampness, rats, and rubbing, and might possibly protect the wire from catching fire if exposed to a gas flame, but to confine the current of electricity, out of doors and on a rainy night, and prevent it from running to ground at every point of

contact, and behaving in the most unaccountable and unseemly manner—that must not be expected of it. I hope that the time is not far distant when "Underwriters" wire will be prohibited from being used in electric lighting by the municipal authorities.

Having, through force of circumstances, entered the electric lighting field, stick to *Arc* lighting. Don't be induced to undertake the incandescent business. The expense of operating and maintaining the incandescent light is much greater and the income to be derived therefrom much less, compared to the cost of the service. Besides, you enter into competition with *yourself*, the worst form of competition. If you furnish a good 20-candle power gas you will be forced to furnish 20-candle power glow lamps or not give satisfaction. This will reduce your rated capacity 20 per cent., and without your being able to get a corresponding increase of rental per lamp. If you can afford to sell your gas at $1.50 per 1,000 you will have to sell your electric lamp at $1.50 per month, with discount to large customers. Even at this price you will not be able to pay large dividends upon your electric business. You cannot induce customers to pay for renewals of lamps burned out, through no carelessness of theirs; neither can you limit the number of hours that they will burn your lamp, when they can have it burning with no extra cost to themselves. The time may come when you will be able to sell the electric current by meter, but it is not yet. Regarding the life of the lamps, I have had more satisfactory results from using the 52-volts lamp than either the 75-volts or 110-volts. Of course the inside wiring must be of larger copper, but the extra life of the lamps will soon recoup the difference in first cost of wiring.

I have tried incandescent lighting by means of a separate dynamo and circuits, and by means of the series lamps on the arc circuit. The two methods at different works. I consider that neither has proved to be a paying investment or business. The only possible consolation I have been able to derive from it is that in one case it helped me to destroy ruinous competition in the gas business, and in the other it has kept out competition in the electric field. In both instances the gas works alone, if safe from wreckers, would pay much better upon the investment.

What has here been said may seem too discouraging to those contemplating entering the electric lighting field. That is not my object. There are many cases where it would be desirable and advisable, and where I should undertake it myself, were I the superintendent of the gas works at those places.

This paper is written with two objects in view:

One is to point out some of the difficulties and disappointments encountered in the field of electric lighting which are not anticipated in our calculations when we are about to install a plant, but which, if more fully known, "might give us pause." In our desire to compass the entire field of artificial illumination we are apt to forget that it is often best to "make haste slowly."

The other object is to provoke discussion. While there is little positive information contained herein, no figures on which to base calculations, and no data to aid you in making the proper allowance in your estimates of expense in operating an electric plant, still there are *hints* that may set you to thinking and enquiring, and by that means may draw forth valuable statistics from those around you who are much more able to supply them.

Some papers are valuable on account of the information contained in themselves, others for the information they elicit in the criticisms they provoke. I live in hopes that this may at least attain to this second class.

Discussion.

THE PRESIDENT—You have doubtless observed that the older members compare pretty favorably with the younger ones after all. Probably at no meeting have we had more diversity in the nature of the papers presented than at this. This is certainly a very valuable paper, and one that we shall be glad to hear discussed thoroughly.

MR. EGNER—I cordially agree with Mr. Boardman in his opinion about high and low-speed engines. I have built and operated steam engines both on land and sea, and I know that what he says is true. There is no denying that the repairs to high-speed engines are much greater. I do not want to say

much about it, except that I believe from my own experience that Mr. Boardman is right I would recommend to everyone to let high-speed engines severely alone.

The President—Is there any high-speed gentleman in the house.

Mr. Glasgow—There is another low-speed gentleman. I want to echo Mr. Boardman's sentiments with regard to engines, and to call attention to this fact, which he, of course, is familiar with, but probably did not bring out very strongly in his paper —and that is that there is another cause, other than the wear and tear, for the loss in the frequent changes of motion in a high-speed engine, and that is because in the better class of low-speed engines there is an entirely different valve gear—the Corliss valve gear.

Mr. Egner—Although I say let high-speed engines severely alone, yet there are occasions where you may have to employ them. For instance, with the Westinghouse engine there are times, occasions, and reasons when that engine would be better than another kind, and perhaps with other high-speed engines there are occasions when they might be used to advantage; but wherever you can use a slow-speed engine in preference to a high-speed engine it is better to do it.

Mr. Hammatt—I would like to ask if anyone here has had any experience with the Evans friction system ?

Mr. Boardman—That is a device for doing away with direct belting ?

Mr. Hammatt—Yes.

Mr. Boardman—Friction on the circumference of the fly-wheel ?

Mr. Hammatt—Yes.

Mr. Gimper—Mr. Boardman says don't go into electric lighting, because the expense of the machinery for electric lighting is so great. Does Mr. Boardman wish to imply that the expense of electric machinery is greater for a gas man than it is for other men ?

Mr. Boardman—No.

MR. GIMPER—If others can afford to pay that price for machinery why cannot gas companies afford to pay it? I do not entirely agree with all that Mr. Boardman said with regard to this. I had some experience for more than a year with electric light plants in connection with the gas business, and am satisfied that an electric light plant in connection with gas is a good thing for the gas company; but I would not advise it for smaller gas companies. That is, I would not advise them to go into competition against another electric light plant. If they have the whole thing to themselves, then I think it is proper, even though they would not make as much upon it, to go into it, although they may simply protect their gas plant in many instances. As to the Evans friction system, I cannot say much about it now, but we will be ready within about two weeks to start such a machine. We adopted it after an investigation, and think it a very good thing. We have made inquiries and investigated it in places where it is in use, and it has been very highly spoken of. It is a system by which you take away entirely all belts. Special pulleys are provided for that purpose.

MR. COGGSHALL—I would like to ask Mr. Boardman if his incandescent lighting was by the alternating current or by the direct current?

MR. BOARDMAN—By the alternating current.

MR. COGGSHALL—Of course, if gas companies are prepared to do arc electric lighting they must be prepared to do incandescent electric lighting. I do not see any difficulty myself in fixing a price that will afford a profit in incandescent lighting as well as arc lighting. Your experience is very much like my own. At the same time, if I were situated as I was before we undertook to do electric lighting I should venture to do it. I should advocate it to my directors. So far we have not seen anything to regret in going into the electric lighting business. I know of an Evans friction pulley that had been operated for a year, and the parties using it did not like it; it had given them a great deal of trouble.

MR. BUTTERWORTH—Mr. Boardman says, in speaking of incandescent electric lights: "Neither can you limit the number

of hours that they will burn your lamp, when they can have it burning with no extra cost to themselves." I would like to ask Mr. Boardman if the electric light meter is not reliable and satisfactory, and if it does not do away with that objection.

THE PRESIDENT—Mr. Boardman will make a note of these questions, and will answer them all at once.

MR. FINDLAY—I would like to ask Mr. Boardman if he ever had any connection with gas works, and an outside company having an electric light plant in the same town?

MR. EGNER—I can answer that with your permission.

MR. BOARDMAN—I would be very glad to have you do so.

MR. EGNER—I built a coal gas works, about two years ago, in a town where they had both arc and incandescent lighting. There was no other light there. Our gas made the electric light people very sick. We got $2 for every dollar that we put in, when we sold out; and the electric light people were the ones who were very glad to buy us out.

MR. FINDLAY—That would be my experience, perhaps, except I might have to start out and butt against that company until they had spent all their money, before they sold out.

MR. BOARDMAN—Before answering the questions which have been asked me I wish to state that when this paper was written I was out of the reach of data, so that I could not put the figures in it that might have been valuable to you. My former assistant, and now successor, is in the room, and I would like to ask him what the comparison of fuel, for instance, has been in his experience in operating high-speed engines as compared with a low-speed engine. I made the assertion when I was some distance from the central station, and made it from memory. I would like to ask Mr. Wilcox, of Macon, Ga., what has been his experience in high-speed engines in the one case, and in the comparatively low-speed Corliss engine in the other, in the mere matter of fuel; and also his general experience with regard to the use of high and low-speed engines.

MR. WILCOX—I have in my pocket a memorandum of the fuel used. It is a statement that I make up every week of the

comparative difference between the high and low-speed engines. I did not know that Mr. Boardman was going to call upon me. I have one Corliss engine that makes 75 revolutions, and one high-speed engine that runs 250 revolutions. With those two working together the consumption of fuel is 4.27 lbs. per horse power; but using the Corliss singly I use 3.60 lbs. per horse power. Running the high-speed engine by itself for street car purposes, making 285 revolutions, I use 5.13 lbs. per horse power. I keep my fuel account for the engines in such a way that I can make the comparison between the two; and we make that test regularly every week. The high-speed engine requires about three times the amount of work on it that the low-speed engine does. It requires extra labor to attend it. For the low-speed engine we can use an average man, and supply the necessary intelligence from the office. You can use a great deal less fuel with the slow-speed engine.

The President—Do you consider that the two engines are equally fair representatives of the two types—about equally new, and in equally good order?

Mr. Wilcox—Yes. I have a No. 1 Corliss engine, and one of the best high-speed engines made; the other two rate about second and third.

Mr. Boardman—Mr. Gimper asked if I had had competition from electric light companies in the same field. The entering upon electric lighting by my company at the time I was in charge was forced upon us by the fact that the Brush Electric Light Company had entered the field, and we were compelled to go into it. They took the entire street lighting of the city from me, and my directors, (under my advice) thought it was better to enter into the competition on that line. The result was that we came into possession at a merely nominal price, as compared with what it cost them, of the entire plant. Therefore, I think it was a good move in my company to enter that field. We got a plant for $15,000 which cost over $33,000; and it was not worth $15,000 when we bought it. (Laughter). I will say in connection with that that the incandescent lighting was not entered into until we had a competitive gas plant, and then we went in for giving all the light that was required, and

that we could furnish. If it had not been for the Standard Oil Company I would have sold kerosene oil to beat them. Mr. Gimper asks with regard to the Evans friction pulley, with no belt. I am not prepared to speak on that question, as I have never seen it in operation; but it strikes me that, unless an excessively large flywheel is employed, you will have to depend upon the high-speed engine in that case as in the other, and upon the various devices for insuring sufficient friction to move the dynamo. Those of you who have had experience in that matter will bear me out in saying that a mere line of friction will necessitate excessive bearings to turn the dynamo without slipping, when we have so much trouble with a belt which covers over two-thirds of the surface of the driving pulley; and I am a little skeptical as to that until I see it further. Mr. Coggshall asked, and I answered, in regard to incandescent lighting by alternating currents. We use the alternating current and reduce it to 52 volts by the interposition of the apparatus used for changing the voltage.

We have found it necessary to fix our price so as to compete with our gas, else we have got to shut down our electric light plant, and the capital we have invested in that and the machinery employed in it must lie idle. We have to compete with our gas plant. Mr. Butterworth asks if the number of hours of burning can be estimated, and if the meter is not a success. I am sorry to say that human nature is such that unless you have separate circuits, by means of which you can put it out at the station at a certain hour, you cannot depend upon your consumers. They will not take the trouble to turn it off when they can go out of the store and leave it burning with no extra cost to themselves. I am sorry to state that that is the fact. We might be in the same condition if we were consumers; but being in a position to criticise the consumers, we must take advantage of it as best we can. They criticise us in our office whenever they have a chance. I think those who have had experience in the matter will bear me out in this statement. And it is but natural. A man, be he ever so desirous to do what is right, cannot strictly attend every night to the turning off at a certain hour of all the electric lights in his establishment. He must leave it to his help, and the help who

may have a ball or a picnic on hand, are in a hurry, and forget to do it. These things do occur. I have had no practical experience with the meter, but I have talked with those who have had, and I have been in towns where the electric light station was in full operation, and selling electric light, both incandescent and arc, I have seen in hotels and in other places where the meter was installed, the lights cut out and no electricity used; whereas those places which had a contract at so much per year were in full blast. I do not think it is yet practicable to use a meter in distributing electric power. Every man is at liberty to have his own opinion about it. Mr. Findlay asked if we had ever had any opposition in electric lighting, and I think that came in Mr. Gimper's question—as to whether we had had competition of other lamps.

Mr. Lansden—I would like to ask whether or not the introduction of electricity in a city, in opposition to the gas company, is not a benefit to the gas company? Is it any detriment to the interests of the gas company for them to undertake to furnish the two kinds of light?

Mr. Hammatt—I have had the same experience that Mr. Boardman has. We had 15 consumers who contracted to turn out their lights, but 14 of them left them burning all night on that circuit. We had to cut them out at the station, or make other arrangements.

Mr. Boardman—In answer to Mr. Lansden's question I will state that in my opinion the ultimate effect of the introduction of electricity, either by a rival company or by your own, is an increase in the sale of gas. In either case it is my opinion that the party benefiting you loses money, be it the electric light company which introduces the light, or be it yourself.

On motion of Mr. Egner a vote of thanks was tendered to Mr. Boardman.

The paper list having been exhausted, attention was next directed to the

QUESTION-BOX.

The first query read was—

"*Is there any instance on record of a gas company obtaining damages from a corporation on account of a change in the established grade of a street, necessitating the lowering of a gas main?*"

MR. PRATT—We had a year ago such an instance in our town (Des Moines, Ia.,) where, after obtaining the grades from the City Engineer, later in the season the grade was changed, necessitating a lowering of our pipes. We did so, and we called upon them to pay damages.

THE PRESIDENT—Were the damages paid voluntarily, or collected by suit?

MR. PRATT—After we had appeared before the Committee and explained the situation, the claim was paid without any contest.

THE PRESIDENT—I have had a similar experience.

MR. BOWEN—I had the same experience, in Westchester, Pa., where the pipes had been laid according to grade, and the grade was afterwards changed. The cost of the change in our pipe system was paid by the authorities, without question.

MR. PRATT—I would also like to add that at the time, in order to head off any difficulty thereafter, we succeeded in getting an ordinance passed by the City Council directing the City Engineer to give us a written statement respecting the grades, and that in case these grades were not followed, the city should remunerate us thereafter.

Question No. II—"Is there any good reason why Gas Companies should not, as a means of encouraging and increasing the consumption of gas, do pipe fitting of houses at cost, and also furnish at cost chandeliers, gas fixtures and burners?"

MR. PRATT—I think there are no good reasons for so doing. Gas companies that put in their own piping will have to carry a large stock of material that they have no use for, and will also have a great deal of waste. The styles in fixtures are constantly changing, and I do not think we should have anything

to do with them except where it is necessary to secure a customer. If we find we shall lose a customer if we do not do it, it might be a good idea to follow the plan in that particular case; but as for carrying a stock of fixtures, I do not think it will pay.

MR. BOWEN—I beg to differ with the gentleman upon that point. The Company with which I am connected have had considerable experience in every branch of the business. In the last few weeks we have not only contracted to do all the pipe fitting and changes, and everything else connected with a very large institution in our town, but we have been compelled to do it by the competition with the electric light people. We find we are able to do the pipe fitting at a cheaper rate than ordinary gas fitters can do it, and can do it as well. If we can get a customer by so doing, we do it. We also furnish gas fixtures the same as we would furnish gas stoves. I think it is perfectly in line for a gas company not only to furnish gas stoves and burners, but gas fixtures as well, whenever it is necessary to extend the business.

MR. GLASGOW—I think the conservative answer to that question would be: There are reasons why gas companies should not undertake this work, and there are also reasons and cases where they should undertake this work, and that these reasons will have to be balanced in each particular case.

MR. FINDLAY—It is a matter of locality entirely. It depends altogether upon how you are situated. If you are fighting someone else, then it would be better to do it; or if someone is fighting against you, you had better do it.

THE PRESIDENT—Then you had better do it anyway?

MR. FINDLAY—That is my opinion.

MR. LITTLEHALES—One reason why we should not do it is in this simple fact: Most towns have at least half a dozen plumbers and gas fitters who have a personal interest in securing work for themselves—they are permanent canvassers for that class of work—and you, by leaving it to them, gain a certain amount of interest in their work; and they in turn are interested to promote your work. The moment you take it in hand you will antagonize those men. I think the average

gas man, if he looks after the manufacturing and distributing plant properly, will have lots to do.

Mr. Forstall—In connection with that I would like to ask how the legal status of a gas company with reference to explosions would be affected by their undertaking to do internal fitting—whether it would not make them more liable for damages for explosions on the inside of buildings.

The President—I think that might be answered affirmatively by almost anyone.

Mr. Rusby—Would they be any more liable for damages than would any private person? Could the owner of a house recover damages from a plumber in case of accident arising from carelessness?

The President—His charges do not make him liable at all; but a gas company, being a corporation, would in every instance be held liable if the sufferer could possibly establish the fact that the injury occurred through the negligence of the company or its agents. Plumbers are generally not corporations.

Question No. III—"Mr. Egner states that 400 pounds of coal are charged into an inclined retort (Coze system) in 8 seconds. If the lid is closed before any gas escapes, can he approximate the saving in gas between this style of charging and the ordinary charging by shovel?"

Mr. Egner—That would be rather guesswork; but from the volume of gas escaping from the mouth of the retort when charged by the shovel, and the very little that escapes when put in by the wagonette and inclined retort, I should say that probably 10 or 15 feet are saved at each charge. Still, that is only guesswork, as I have not metered that gas.

Question No. IV—"Mr. Egner is asked whether he prefers inclined retorts or water gas. By special request."

Mr. Egner—That is another thing that depends on the location, the cost of material used, and the process employed. At St. Louis, for instance, if we use the process which we now have, and only have to pay for the material what it now costs us, I would say right here that we could make water gas cheaper

than we could make coal gas with the apparatus that we have. We have only enough to make about 350,000 feet, and we did not find out how good it was until within the last year.

THE PRESIDENT—The gentleman will not under any circumstances mention whose apparatus it is.

MR. EGNER—I will not Mr. President; I am too modest to say that. (Laughter and applause.)

VOTES OF THANKS.

MR. HARBISON—It has been very gratifying to me personally, as I know it has been to every other member of this Association, to see so large an attendance at this meeting. Many of us have come from a great distance; and many of us have come for the first time into this section of the country, that we have heard so much about. Many have brought with them members of their families. We have had special care taken of us while here, and from what we have already received we expect that care to continue while we yet remain. I think before we separate it should be our duty, as I know it is our pleasure, to put on our record a vote of thanks to those who have done so much for us by way of attention to our comfort. I therefore move that the thanks of this Association be voted to our hosts, the United Gas Improvement Company, of Philadelphia; to the Committee of Arrangements which you appointed to look after our affairs here in the way of providing for our business meetings and for our entertainment, in providing us with such hotel accommodations; to the local Gas Company, through its representatives and managers, for the exceedingly attentive care they have given us, and the liberal provision they have made for our comfort and welfare. These thanks are due from us as an Association as well as from us as individuals.

MR. BOARDMAN—I arose to do what my friend did quicker than I; but I cannot refrain from stating, as a member of the Committee of Arrangements, that the entire credit is due to the U. G. I. Company, and to its efficient staff, who so ably seconded the endeavor of the General Superintendent to add to our pleasure. I will second the motion of Mr. Harbison, with the

request, with his permission, that to that vote of thanks be added the thanks of the Association to the Ladies' Reception Committee, and to those gentlemen who have so kindly seconded them in receiving the fairer guests of this Association, and welcoming them to the city of Savannah and to this meeting.

THE PRESIDENT—All in favor of that motion will rise to their feet. It is carried unanimously. What further business?

MR. GLASGOW—I move you that the Council of this Association be requested to put in rigid execution that clause of the Constitution which forbids members owing two years' dues participating in the deliberations of the Association. (Seconded by Mr. Findlay, and adopted unanimously.)

At this point President McMillin vacated the chair, which was taken by President-elect Harbison.

MR. LITTLEHALES—Mr. Chairman: I move a hearty vote of thanks to our President for the able manner in which the business of this Association has been conducted. I do not remember of any meeting that I have ever attended where business has been put through with greater promptness, or conducted in better order. I am sure that every one will coincide with my remarks upon that point, and that my motion will meet your hearty appreciation.

MR. A. C. HUMPHREYS—I second the motion.

THE CHAIRMAN—It has been moved and seconded that the hearty thanks of the Association be tendered to President McMillin for the very able and efficient manner in which he has presided over our deliberations during the year. It is not necessary to add another word to what has been said by Mr. Littlehales. All in favor of the motion will manifest it by rising. I will not call for the opposite vote, for I see that every member is on his feet.

MR. McMILLIN—I think you are mistaken, Mr. Chairman, for I did not get up. I feel very grateful for this vote, but shall not take any of your time by attempting to make a fitting response. I only want to say that it has never been my good fortune before to preside over a body of men that I enjoyed

presiding over more than I have the American Gas Light Association. It has not been my good fortune to preside in any place where there were more efficient workers, and where they kept to the points under discussion, or where they observed all the little rules that are necessary for the expedition of business, than has been done by this Association. Much of the work that has been accomplished has been due to the very great aid that I have had from the Secretary, and from the two Vice-Presidents. You will remember that the First and Second Vice-Presidents have occupied the chair about as much as I have; and if I had been kept in the chair all the time I would have got pretty stupid before now; but through their assistance I think we have had a very good meeting. (Applause.)

THE CHAIRMAN—Is there any further business to come before the Association?

MR. FORSTALL—While the President has had a good deal to do with the actual meeting, yet I think that, the larger part of the work on which the success of a meeting depends usually falls upon the Secretary. I, therefore, move that the thanks of the Association be tendered to our Secretary and Treasurer, Mr. Humphreys, for the large amount of work that he has done in getting ready for the meeting.

THE CHAIRMAN—It is moved and seconded that the thanks of the Association be tendered to Secretary Humphreys for his very efficient work during the past year as Secretary and Treasurer of this Association. Are you ready for the question? Those who favor the vote will rise. It is unanimously voted. Mr. Secretary, the Association tenders you a unanimous vote of thanks for your efficient services during the year.

THE SECRETARY—Mr. Chairman, and Gentlemen of the Association: As you are very apt, in your over-appreciation of the work of the Secretary, to extend to him an annual vote of thanks, you must expect that his annual acknowledgment will be pretty much the same old story. However, I thoroughly appreciate your kind vote, and thank you very much for it. I would just like to add one word more: I have now been Secretary of this Association since 1883. During that time the

duties of the office have increased very much—so much so that I do not feel justified in continuing in office longer. I have not felt justified in taking the office this year, but I was over-persuaded by the President-elect to accept the office for another year. I think, however, it is only right that I should say at this time that my connection with this office must cease at the end of the coming year. I presume that in making a statement of this kind, in declining an office which really has not been tendered to me, I am laying myself open to a charge of inconsistency, but I make the statement now so that you may have ample opportunity to find my successor.

Mr. McMillin—The remarks of the Secretary leave us in rather a bad position. We hardly know whether to applaud or not. We would like to applaud his speech, but we do not like to applaud the sentiment.

The Chairman—Permit me to say that it has only been by—if I may so state it—almost my command that he has consented to serve in the position of Secretary for another year, and for this I know that every member of the Association feels profoundly grateful. (Applause.) I have that feeling of regard for Mr. Humphreys (which I am happy to believe he has for me—undeserved as it is) that I doubt very much, and I am conceited enough to think that it is perhaps true, that for no other member of this Association would he have consented to serve another year. Knowing the importance of the position, the duties to be performed, and the comparatively few men there are in our midst who, although capable, can devote the necessary time to the successful performance of the duties of that office, the matter should be carefully canvassed in advance, so that when the time comes for you to make the selection of his successor no mistake shall be made. The interests of the Association have grown and are growing, and the position of Secretary becomes more and more important every year. I make this statement of the case to you so that your minds may be circulating around among the membership, to see who of all is best fitted to perform the duties, and who can devote the necessary time to them.

(President McMillin resumes the chair.)

Mr. Egner—Mr. President, I would now like to make a motion. The First Vice-President having done something here as Vice-President, for which he certainly ought to have a vote of thanks—for he himself has said it—therefore I think he ought to have it. And although the other Vice-President has said nothing, we think he ought not to be neglected; hence I move a vote of thanks to the First and Second Vice-Presidents of the Association for the aid they have given us. (Seconded by Mr. Glasgow.) (Carried.)

On motion of Mr. Harbison the business sessions of the Association were declared closed.

J. H. Harbison

NINETEENTH ANNUAL MEETING

OF THE

AMERICAN GAS LIGHT ASSOCIATION,

HELD AT

SCOTTISH RITE HALL, NEW YORK,

OCTOBER 21, 22 AND 23, 1891.

FIRST DAY—OCTOBER 21—MORNING SESSION.

The Association was called to order at 10 A. M. In the absence of the President, Mr. John P. Harbison, the First Vice-President, Capt. William Henry White, took the chair. In the absence of Mr. C. J. R. Humphreys, Secretary, Mr. Alex. C. Humphreys acted as Secretary.

On motion of Mr. Slater the reading of the minutes of the last meeting was dispensed with.

ROLL CALL.

The following members were in attendance:

Honorary Member.

Prof. E. G. Love, New York, N. Y.

Active Members.

Abel, W. G.,	Atlanta, Ga.
Adams, H. C.,	Philadelphia, Pa.
Adams, W. C.,	Richmond, Va.
Addicks, F. P.,	Boston, Mass.
Addicks, W. R.,	Boston, Mass.

A[illegible]n, A. L.,	Poughkeepsie, N. Y.
Andrew, J.,	Chelsea, Mass.
Atwood, H. A.,	Plymouth, Mass.
Bailey, C. B.,	Washington, D. C.
Bates, J. W.,	Hoboken, N. J.
Baumgardner, J. H.,	Lancaster, Pa.
Baxter, I. C.,	Detroit, Mich.
Baxter, R.,	Halifax, N. S.
Beal, W. R.,	New York, N. Y.
Benson, F. S.,	Brooklyn, N. Y.
Betts, E.,	Wilmington, Del.
Bill, G. D.,	Malden, Mass.
Blauvelt, C. D.,	St. Augustine, Fla.
Blodgett, C. W.,	Brooklyn, N. Y.
Boardman, A.,	Macon, Ga.
Boardman, H.,	Bangor, Me.
Borgner, C.,	Philadelphia, Pa.
Bowen, W. S.,	West Chester, Pa.
Bradley, W. H.,	New York, N. Y.
Bredel, F.,	Milwaukee, Wis.
Brown, E. C.,	New York, N. Y.
Buckman, J.,	Philadelphia, Pa.
Burtis, P. T.,	Mt. Holly, N. J.
Bush, J. S.,	New York, N. Y.
Butterworth, I.,	Columbus, O.
Byrne, T. E.,	Brooklyn, N. Y.
Cabot, J.,	New York, N. Y.
Cartwright, M.,	Rochester, N. Y.
Cartwright, W.,	Philadelphia, Pa.
Chadwick, H. J.,	Lockport, N. Y.
Clarke, G. S.,	Kansas City, Mo.
Clark, W.,	Philadelphia, Pa.
Coggshall, H. F.,	Fitchburg, Mass.
Cole, T. W.,	Altoona, Pa.
Collins, A. P.,	New Britain, Conn.
Collins, C. R.,	Philadelphia, Pa.
Connelly, J. S.,	New York, N. Y.
Connelly, T. E.,	New York, N. Y.
Copp, A. M.,	Boston, Mass.

C. H.,	Brooklyn, N. Y.
T. C.,	Yonkers, N. Y.
, E. G.,	Milwaukee, Wis.
J. H.,	Buffalo, N. Y.
.,	Boston, Mass.
). W.,	Northampton, Mass.
A. D.,	Fort Wayne, Ind.
J. A. P.,	Philadelphia, Pa.
, J. B.,	San Francisco, Cal.
,	Detroit, Mich.
.,	Wilmington, Del.
R.,	Jersey City, N, J.
J. M.,	Columbia, S. C.
J.,	Waltham, Mass.
R.,	Athol, Mass.
	St. Louis, Mo.
C. H.,	Baltimore, Md.
R. R.,	Dayton, O.
F. A.,	Philadelphia, Pa.
.. M.,	New York, N. Y.
D.,	Savannah, Ga.
, G. B.,	New York, N. Y.
.,	New York, N. Y.
Vm. L., Jr.	Philadelphia, Pa.
. R., Jr.,	Toledo, O.
J. H.,	Ogdensburg, N. Y.
g, D. D.,	Jersey City, N. J.
. W.,	New York, N. Y.
I. E.,	New York, N. Y.
. R.,	New York, N. Y.
V. P.,	Philadelphia, Pa.
T. B.,	Astoria, N. Y.
J.,	Chattanooga, Tenn.
A. E.,	Newark, N. J.
J.,	Philadelphia, Pa.
.,	Lynn, Mass.
. J., Jr.	Pittsburg, Pa.
. W.,	Hamilton, Ontario.
D. H.,	Quebec, Canada.

Gerould, C. L.,	Brooklyn, N. Y.
Gerould, L. P.,	Brooklyn, N. Y.
Glasgow, A. G.,	Philadelphia, Pa.
Gordon, J. J.,	Cincinnati, O.
Graeff, G. W., Jr.,	Philadelphia, Pa.
Graves, H. C.,	Dayton, O.
Gribbel, J.,	New York, N. Y.
Griffin, J. J.,	Philadelphia, Pa.
Gywnn, J. W.,	Bucyrus, O.
Hallett, J. L.,	New York, N. Y.
Hambleton, F. H.,	Baltimore, Md.
Harbison, J. P.,	Hartford, Conn.
Hauk, C. D.,	Chicago, Ill.
Hayward, T. J.,	Baltimore, Md.
Helme, W. E.,	Philadelphia, Pa.
Hookey, G. S.,	Augusta, Ga.
Humes, W. S.,	Altoona, Pa.
Humphreys, A. C.,	Philadelphia, Pa.
Kreischer, G. F.,	New York, N. Y.
Kuehn, J. L.,	York, Pa.
Lamson, C. D.,	Worcester, Mass.
Leach, Henry B.,	Taunton, Mass.
Learned, E. C.,	New Britain, Conn.
Learned, Waldo A.,	Newton, Mass.
Lindsley, Edward,	Cleveland, O.
Littlehales, T.,	Hamilton, Ont.
Littleton, A. W.,	Quincy, Ill.
Loomis, Burdette,	Hartford, Conn.
Ludlam, Edwin,	Brooklyn, N. Y.
Macdonald, B. J.,	Newburgh, N. Y.
Mayer, Frederick,	Baltimore, Md.
McCleary, A. J.,	Philadelphia, Pa.
McCullough, E. H.,	Philadelphia, Pa.
McCutcheon, J.,	Allegheny, Pa.
McDonald, W.,	Albany, N. Y.
McElroy, J. H.,	Pittsburgh, Pa.
McIlhenny, J.,	Philadelphia, Pa.
McIlhenny, J. S.,	Washington, D. C.
McKeige, F.,	New York, N. Y.

McMillin, E., - - -	Columbus, O.
Merrifield, P. S., - - -	New York, N. Y.
Miller, A. S., - - -	Omaha, Neb.
Milsted, W. N., - - -	New York, N. Y.
Mitchell, K. M., - -	St. Joseph, Mo.
Murphy, H., - - -	Sing Sing, N. Y.
Neal, G. B. - - -	Boston, Mass.
Nettleton, C., - - -	New York, N. Y.
Nettleton, C. H., - -	Birmingham, Conn.
Norris, R., - - - -	Philadelphia, Pa.
Nute, J. E., - - -	Fall River, Mass.
O'Brien, W. J., - - -	Philadelphia, Pa.
Odiorne, F. H., - -	Boston, Mass.
Page, G. S., - - -	New York, N. Y.
Park, W. K., - - -	Philadelphia, Pa.
Pearson, W. H., - - -	Toronto, Ont.
Pearson, W. H., Jr., - -	Belleville, Ont.
Perkins, J. D., - - -	New York, N. Y.
Peters, M., - - -	New York, N. Y.
Phelps, E. R., - - -	White Plains, N. Y.
Pratt, E. G., - - -	Des Moines, Ia.
Prichard, C. F., - - -	Lynn, Mass.
Quinn, A. K., - - -	Newport, R. I.
Ramsdell, G. G. - - -	Philadelphia, Pa.
Richardson, F. S., - -	North Adams, Mass.
Rogers, J. F., - - -	Jamaica Plain, Mass.
Roots, D. T., - - -	Connersville, Ind.
Rowland, C. L., - - -	Brooklyn, N. Y.
Rowland, W. L., - -	Philadelphia, Pa.
Rusby, J. M., - - -	Jersey City, N. J.
Russell, D. R. - - -	St. Louis, Mo.
Scrafford, Wm. H., - -	Bath, N. Y.
Seaverns, F., - - -	New York, N. Y.
Scriver, J. F., - - -	Montreal, Can.
Shelton, F. H., - - -	Chicago, Ill.
Sherman, F. C., - - -	New Haven, Conn.
Sisson, F. N., - - -	Albany, N. Y.
Slade, J., - - - -	Yonkers, N. Y.
Slaney, H. C., - - -	Brooklyn, N. Y.

Slater, A. B., - - -	Providence, R. I.
Slater, A. B., Jr., - -	Providence, R. I.
Smith, J. W., - - -	Philadelphia, Pa.
Smith, M., - - -	Wilkes Barre, Pa.
Smith, R. A. C., - - -	New York, N. Y.
Snow, W. H., - - -	Holyoke, Mass.
Somerville, J., - - -	Indianapolis, Ind.
Spaulding, C. F., - -	Waltham, Mass.
Spaulding, C. S., - - -	Brookline, Mass.
Spaulding, W. H., - -	Clinton, Mass.
Stacy, Wm., - - -	Cincinnati, O.
Stanley, Ira N., - -	Brooklyn, N. Y.
Stedman, Wm. A., - - -	St. Louis, Mo.
Taber, R. B., - - -	Boston, Mass.
Thomas, J. R., - - -	New York, N. Y.
Townsend, S. S., - -	New York, N. Y.
Turner, T., - - - -	Charleston, S. C.
Van Benschoten, C. C., - -	New Rochelle, N. Y.
Vanderpool, E., - - -	Newark, N. J.
Waldo, C. S., - - -	Boston, Mass.
Waldo, J. A., - - -	Boston, Mass.
Watson, C., - - -	Camden, N. J.
Weber, O. B., - - -	New York, N. Y.
White, C. A., - - -	New York, N. Y.
White, W. H., - - -	New York, N. Y.
Whittier, C. R., - -	New York, N. Y.
Wilcox, H. K., - - -	Middletown, N. Y.
Williams, E. H., - -	Waterbury, Conn.
Williams, W. L., - - -	Paterson, N. J.
Wood, A. C., - - -	Syracuse, N. Y.
Wood, W. A., - - -	Dorchester, Mass.
Yorke, E. H., - - -	Brockton, Mass.
Young, P., - - - -	Knoxville, Tenn.

Associate Members.

Crane, W. M., - - -	New York, N. Y.
Essick, W. S., - - -	Royersford, Pa.
Hayward, S. F., - -	New York, N. Y.
Norton, H. A., - - -	Boston, Mass.

Osius, G.,	Detroit, Mich.
Persons, F. R.,	Chicago, Ill.

REPORT OF COUNCIL.

The Secretary read the following report:

The Council has approved of the following applications for membership, and submits them to the Association with a recommendation for favorable action:

Active Members.

*Africa, Walter G.,	Manchester, N. H.
Beadenkopf, Geo.,	Baltimore, Md.
*Beadle, A. B.,	St. Albans, Vt.
Beal, Thaddeus,	New York, N. Y.
*Bennett, C. A., Jr.,	Freehold, N. J.
*Clary, E. D.,	Burlington, Iowa.
*Collins, John,	Fishkill, N. Y.
*Crowell, F. B.,	New York, N. Y.
Dougherty, Daniel J.,	Brunswick, Ga.
*Douglas, Henry W.,	Ann Arbor, Mich.
Dyer, Frank H.,	Salt Lake City, Utah.
*Fowler, Samuel J.,	Springfield, Mass.
Fullagar, Wm. E.,	Port Jervis, N. Y.
*Gandey, A. C.,	Lambertville, N. J.
*Giblin, John A.,	Ilion, N. Y.
*Gifford, N. W.,	New Bedford, Mass.
*Guildlin, O. N.,	Akron, Ohio.
*Hunt, Thomas,	Tonawanda, N. Y.
*Jenkins, E. H.,	Columbus, Ga.
Jourdan, J. H.,	Brooklyn, N. Y.
*Keppelman, John H.,	Reading, Pa.
Knight, E. B ,	Hagerstown, Md.
Lane, Jas. W.,	Akron, Ohio.
*Lillie, Lewis,	Pensacola, Fla.
McMillin, Geo.,	La Crosse, Wis.
Miller, C. O. G.,	San Francisco, Cal.

*Present at this meeting.

Nash, A. F.,	- - -	Ontario, Can.
*Pinkney, E. A.,	- - -	Utica, N. Y.
Procter, Wm. L.	- -	Ogdensburg, N. Y.
Rawn, J. C.,	- - -	Roanoke, Va.
*Reilly, John W.	- -	Wilmington, N. C.
*Serrill, Wm. J.,	- - -	Allentown, Pa.
*Smith, W. H.,	- - -	Bayonne, N. J.
Steck, Henry,	- - -	Hagerstown, Md.
*Thompson, Geo. T.,	- -	St. Louis, Mo.
*Tracy, John,	- - -	Poughkeepsie, N. Y.
*Walters, A. H.,	- -	Johnstown, Pa.
*Warmington, Daniel R.,	- -	Cleveland, O.
Watt, Anthony,	- - -	Connorsville, Ind.
White, H. H.,	- - -	Belleville, Ill.
*Whitney, H. C.	- -	Watertown, N. Y.

Associate Members.

*Adams, Chas. F.,	- - -	Buffalo, N. Y.
Gray, Jerome B.,	- -	Philadelphia, Pa.
*Higgins, C. M.,	- - -	New York, N. Y.
*McDonald, Donald,	- -	Albany, N. Y.
*Manning, Jas.,	- - -	New York, N. Y.
Steen, Wm. E.,	- - -	Philadelphia, Pa.
*Yuille, Geo. A.,	- - -	Chicago, Ill.,
*Page, Harry DeB.,	- -	New York, N. Y.
*Page, Albion L.,	- - -	New York, N. Y.
Bradley, Carl D.,	- -	Chicago, Ill.

Transfer from Associate to Active.

Croul, Jerome,	- - -	Detroit, Mich.

Summary: Active, 41; Associate, 10; Transfer, 1; total New Members, 51.

It is to be noted this is the largest number ever applying for membership at one meeting.

Respectfully,

WM. HENRY WHITE, *Vice-President.*

ALEX. C. HUMPHREYS, *Acting Secretary.*

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*Present at this meeting.

ELECTION OF MEMBERS.

THE PRESIDENT—You have heard the list of applicants for membership of the several classes. These names have been under consideration by your Council, and this report is from the Council. The gentlemen are therefore all eligible to election. On motion of Mr. Cornell, the Secretary cast the ballot of the Association for the gentlemen named.

THE PRESIDENT—I have the pleasure of announcing the election of the gentlemen whose names have been read to you. So many of the gentlemen as are present here will please rise in their places. Gentlemen, I have the pleasure of extending to you a hearty welcome from the Association into its membership. Gentlemen of the Association, I ask you to look upon your new members and extend to them the right hand of fellowship, and a hearty greeting.

The new members present arose in response to the introduction of the Chairman.

THE PRESIDENT—You will now give your attention to the reading of the report of your Council on the management of the affairs of the Association during the year.

The Secretary, (reading):

REPORT OF COUNCIL.

NEW YORK, October 20th, 1891.

To the Members of the Association:

GENTLEMEN:—Your Council begs leave to report that the following papers have been approved, to be read at this meeting.

"Leakage," by C. H. Nettleton, Birmingham, Conn.

"Meter Rent, a Question of Policy," by Walton Clark, Philadelphia, Pa.

"The Illuminating Power of Mixture of Coal and Water Gases," by Dr. E. G. Love, New York.

"Theoretical Effect of Preheating Blast, Steam and Oil in Water Gas Manufacture," by Rollin Norris, Philadelphia, Pa.

"Lime," by Dr. A. W. Wilkinson, New York.

"Intensity of Light," by A. B. Slater, Jr., Providence, R. I.

"Manipulation of Tar from Carbureted Water Gas," by David Douglas, Savannah, Ga.

The following have been appointed as the Committee on Nominations:

E. G. Cowdery, Chairman, Milwaukee, Wis.; C. W. Blodgett, Brooklyn, N. Y.; Alex. C. Humphreys, Philadelphia, Pa.; Thos. Turner, Charleston, S. C.; A. B. Slater, Jr., Providence, R. I.

Your Council has to report that, owing to lack of funds, it was unable to proceed with the publication of Vol. 9 of the Proceedings, as authorized at last year's meeting. This shortness of funds was largely owing to the indifference displayed by the members as to the payment of their dues. It is to be remembered that October, '90, it was necessary to drop from our roll, for non-payment of dues, 13 active members, and at the meeting just held it has been necessary to take action looking to the dropping of 6 more.

The members are respectively urged to remit their dues promptly each year to the Treasurer, on Oct. 1, and not to wait for the time of the meeting. If left until then it is apt to be neglected in the rush of business, and it is also not so convenient a time for the Treasurer to receive money. It is to be remembered that our Constitution makes the dues payable Oct. 1 of each year, in advance. Members in arrears are urged to make immediate settlement.

An estimate made as to the condition of our treasury for the current year shows that if the members will give attention to the above appeal, we shall have sufficient funds to pay for printing Vol. 9, of our Proceedings. We therefore recommend that this volume be printed, to contain not only the years '89 and '90, as last year contemplated, but also '91.

Your Council also urges upon the members, as a means of affording further relief to the treasury, and also as a wise move on the part of the members individually, that all those who have not complete sets of the Proceedings should purchase from the Association the missing volumes. Certainly every member of the Association should have access to a complete record of its Proceedings. For Vol. I (paper cover) is charged $1 each; for all the other volumes, $1.50 each.

It has been deemed wise to make certain changes in the regulations as to papers for meetings. Hereafter the authors of papers will be selected and arranged for not later than Jan. 1, of each year, and in so arranging it will be understood the papers must all be in the Secretary's hands not later than Sept. 1. It is thought that this will be the opposite of a hardship, if once inaugurated. This will enable the Secretary to arrange very cheaply for the printing and distribution to members in advance of the papers to be read, and your Council recommends this course for the future. It is estimated that the cost per year will not exceed $100 on an average.

Your Council urges upon the members the propriety of giving prompt and accurate replies to the inquiries sent out by the Secretary, in connection with the preparation of the yearly list of members. In the past some of the members have exhibited great indifference on this subject, until this indifference resulted in the list showing their names or accompanying statements incorrectly; then a complaint has generally been promptly made by the hitherto indifferent members.

In the preparation of future lists of members it has been decided to print, under an appropriate heading, the names of all members who have from the first died while upon our roll.

Your Council recommends that the Secretary be instructed to furnish to the *American Gas Light Journal*, *Light, Heat and Power*, and *Progressive Age*, each one copy of the proceedings of this meeting, and collect from each of these papers one-third of the total cost of the reporting of the proceedings.

As the question has been raised, it is to be noted that to prevent question as to the personnel of the Council during the last day of the meetings, and to extend by one day the time for which railroad ticket certificates can be made valid, the final adjournment each year will be had at the end of the entertainment programme of Friday.

Your Council recommends the adoption of the following, as an amendment to Section 6 of the Constitution. Add at the end:

"Or occupy such a position in his company as is usually designated by one of the titles herein specified."

The present rule has worked unfairly in some instances, and

it is believed that this amendment will safely correct this tendency. Your Council recommends the adoption of the following amendments to the Constitution:

Sec. 46—After the word "shall" and before the word "include" insert the word "not."

Sec. 47—The same change.

Sec. 16—After the words "initiation fee" insert the words "and one year's dues as provided for in Secs. 48 and 49."

The Finance Committee has examined the books and accounts of the Treasurer and of the acting Treasurer, and has found the same to be correct, as shown by its report herewith submitted.

Respectfully submitted,

WM. HENRY WHITE, *Acting President.*

ALEX. C. HUMPHREYS, *Acting Sec. and Treas.*

THE PRESIDENT—You have heard read the report and recommendations of your Council. Is it your pleasure to act upon the report as a whole, or will you have each suggestion presented and considered? What is the desire of the meeting?

MR. LAMSON—I move that the recommendations of the Council be adopted as a whole.

THE PRESIDENT—You understand that this practically includes certain amendments to the Constitution.

MR. GATES—Would it not be well to read those particular portions again, because we cannot understand them as read.

THE PRESIDENT—It so strikes the Chair. I think if you pass everything contained in the report in an omnibus bill, except the suggested amendments to the Constitution, it would be well. If you choose you can amend your motion to that effect—that all but the suggested amendments to the Constitution be concurred in.

MR. GATES—I move that. [Unanimously carried.]

THE PRESIDENT—The Secretary will now read the proposed amendments to the Constitution—first reading the articles as they are, and then the proposed change.

THE SECRETARY—The first proposed amendment refers to

Sec. 6 of the Constitution, as to eligibility for active membership. The section reads at present:

"6. To be eligible as an active member, a person must be a president, secretary, treasurer, engineer, consulting engineer, or superintendent of a gas company, or a manager of a gas works."

It is proposed to add to that section the words as follows:

"Or occupy such a position in his company as is usually designated by one of the titles herein specified."

THE PRESIDENT—The object of that amendment is this: The Council finds itself every year confronted with this dilemma—that applications are made for active membership by gentlemen who are clearly engaged in the duties of, or are acting as, superintendents, yet who at the same time only hold rank as assistant superintendents; or the applicant is a practical man, such a man as ought to be here with us, and whom we want to have with us, but as to whose admission your Council entertained varying views. They desire to have this clearly and definitely brought before you, in order that it may be made a part of your Constitution. It strikes the Chair that this is a very desirable amendment. What is your pleasure in connection with this amendment?

MR. CORNELL—I move that it be adopted.

MR. PRESIDENT—It has been regularly moved and seconded that the proposed amendment to Section 6 of the Constitution be adopted. Does anyone desire to speak on the motion?

MR. A. C. WOOD—I scarcely see the object of this proposed amendment, for it occurs to me that the matter is fully defined in the Constitution as it now reads, and this, then, seems to me to be a re-enacting of a previous provision in this section. Will the Secretary read that again, so we may all clearly understand it?

THE SECRETARY—Section 6 as it is now, provides that a man has to be "a President, Secretary, Treasurer, Engineer, Consulting Engineer, or Superintendent of a Gas Company, or a Manager of a Gas Works," in order to be eligible as an active member. The proposed addition is, "or occupy such a position in his company as is usually designated by one of the titles

herein specified." It has been found in past years, and was found this year, that applications for membership were made by young men who did not hold any of those titles, but who did in effect hold one of those positions—they were not designated by either of those titles, but they had the position. They were managers of gas works, and perhaps had the title conferred upon them of assistant superintendent; nevertheless, they were under an assignment of duty which clearly made them managers of a gas works. In the same way, an assistant engineer is not eligible under the strict reading of that section, but still there may be an assistant engineer of a large company, having a number of different works in one city, who is not only the manager of a gas works, but he may be the manager of two or three gas works, under the chief engineer, and ranking as the manager of the works. I can enumerate two or three such cases that I have personally come in contact with. The object of this amendment is simply to give the Council the right to act within the law, instead of trying to stretch the law.

THE SECRETARY—The amendment adds right on to this section, after it mentions the officers that may be eligible for active service, the statement that those who occupy such a position in the company as is usually designated by one of the titles therein specified, shall be eligible to active membership. The Council, in taking the matter under consideration last night, unanimously came to the conclusion that with such an amendment, if they were upon investigation led to find that a man who was an assistant superintendent, was really by assignment of duty by his superior officer, made manager of a gas works, he could come in under this amendment; whereas, it might be a little stretch of the section to bring him in under the Constitution as it now reads. In the same way, an assistant engineer, if it could be shown that he was in charge of a gas works, would be clearly covered by this amendment. In the same way a Vice-President, by this Constitution, is not eligible for active membership, but with this proposed addition to Section 6, he would be eligible, if he was an active man, because he would be either a manager, by assignment of duty, or else be acting as president. It is to cover those cases, where, after investigation, it was found that a man was occupying a position

equal to one of those designated under the Constitution, that we could let him in as an active member without violating the rules.

THE PRESIDENT—Does any gentleman desire to further discuss the subject? How shall this ballot be taken?

MR. NETTLETON—I move that the Secretary cast the ballot of the Association.

THE PRESIDENT—Unanimous consent is necessary before he can do that. Is there any objection? There being no objection, I will ask Mr. Slater again to act as teller, while the Secretary casts the ballot of the Association for the proposed amendment.

THE SECRETARY—Unless I hear an objection, I shall cast the unanimous vote of this Association in favor of the adoption of the proposed amendment. Is there any objection?

THE PRESIDENT—There is no objection, and you will cast the ballot.

MR. SLATER—I have assorted and counted the ballots, and I find it to be a unanimous vote.

THE PRESIDENT—I declare the proposed amendment to Section 6 of the Constitution unanimously adopted.

Please give your attention to the reading of the second proposed amendment.

THE SECRETARY—This other recommendation rather looks as though two or three amendments were included, but they all cover one point, and to effect this change it is necessary to change the wording of the Constitution in three places. The idea is that instead of having the initiation fee of $10 include the first year's dues in advance, as is now the case, to have that initiation fee not include the first year's dues. In other words, a man who is elected to membership will be called upon to pay an initiation fee of $10, and at the same time he will also be called upon to pay his annual dues in advance, the same as the rest of the members. To bring about that result it is necessary

to amend Sections 46 and 47 by inserting the word "not" in each section, so that they shall read, as amended:

"46. Every person elected as an Active Member shall pay an initiation fee of ten dollars, which shall *not* include the dues for the current year."

"47. Every person elected as an Associate Member shall pay an initiation fee of ten dollars, which shall *not* include the dues for the current year."

It is necessary also to amend Section 16 by inserting the words "and one year's dues as provided for in Sections 48 and 49." Sections 48 and 49 simply state that "every active member shall pay annually, in advance, the sum of five dollars," and "every associate member shall pay annually, in advance, the sum of five dollars." This Section 16, with the proposed amendment, will read:

"16. Any person elected to the Association, excepting Honorary Members, must subscribe to the rules, and pay to the Treasurer the initiation fee, *and one year's dues as provided for in Sections 48 and 49*, before he can receive a certificate of membership. If this is not done within six months of notification of election the election shall be void."

THE PRESIDENT—What is the pleasure of the Association with respect to these proposed amendments?

MR. GATES—I move that the Secretary cast the ballot of the Association for their adoption.

MR. LITTLEHALES—With all due respect to the recommendations of the Council upon the matter, I think that is a mistake, and for this reason. It means an additional fee to be paid by those joining the Association. That might be one means of raising the wind, but I think it would be much more in accordance with the fitness of things if existing members paid up their dues, and rendered this collection from new members unnecessary. As most of the prospective members of this Association will be connected with smaller works, it would seem to be rather hard to increase the amount which they shall pay on

becoming members. As the larger companies are nearly all represented, and the prospective membership must come from the smaller companies, many of those men have to pay the dues themselves—they are not paid by their companies. Therefore, I think it is a mistake to raise the entrance fee unduly high.

THE PRESIDENT—The Chair might state for the information of gentlemen the reasons which led the Council to take this action. Some of you may possibly have forgotten the fact that a few years ago the Association voted to present to each member a badge, and to all incoming members the badge practically represents a cost of $5. Therefore, the incoming member, upon paying an initiation fee of $10, gets at once $5 worth of badge handed back to him, and $5 for his first year's dues; so that he practically gets his $10 back the first year. The purchase of those badges depleted the treasury, and the Association has not yet recovered from that condition. We have furnished ourselves with badges costing $5 apiece (and of course for small numbers the price is increased), and we felt that gentlemen coming into the Association hereafter would not object to paying $5 for their badges. Therefore, this amendment was presented by the Council. It is presented for your consideration. In offering it, the Council simply represent their own ideas on the subject, and are very glad to have yours. They desire to have the question fully discussed. The matter is still open for your discussion.

MR. GRAEFF—I think if the Secretary would glance at the rolls of some of the electric light associations he will find that they are growing quite as rapidly as this Association, and yet they have an initiation fee of $20, at the lowest.

THE PRESIDENT—I think you are quite right, and that we require a very small initiation fee in proportion to the benefits to be derived from membership in this Association. I do not think that the requirement of an additional $5 would prevent anyone from coming in. The Chair will say, in reply to the suggestion of Mr. Littlehales, that, as our recruits are to come from the young men, it would seem that the young men would be very glad to pay $5 for the privilege of wearing this handsome deco-

ration. Is there any further discussion? It has been moved and seconded that this recommendation of amendments to the Constitution be adopted, and that the Secretary cast the unanimous vote of the Association. He can only do so by your unanimous consent. Is there any objection to such course? There being no objection, the Secretary will please cast the ballot, and Mr. Slater will again oblige us by acting as teller.

THE SECRETARY—Is there any objection to my casting the ballot of the Association for the adoption of the proposed amendments? Hearing none, I cast the ballot of the Association.

MR. SLATER—Your teller has assorted and counted the ballots, and finds a unanimous vote in favor of the adoption of the proposed amendments.

THE PRESIDENT—The Chair announces that the proposed amendments to the Constitution on the subject of initiation fees and dues have been unanimously adopted.

REPORTS OF SECRETARY AND TREASURER.

You will now give your attention to the reading of the reports of your Secretary and Treasurer, and also of the Finance Committee.

The Secretary read the following report:

REPORT OF (ACTING) SECRETARY FOR THE YEAR ENDING SEPT. 30, 1891.

Honorary Members.

Published list of 1890	6	
Died between publication and Secretary's final report to Association, Oct. 1, 1890	1	
Shown by Secretary's report, Oct. 1, 1890	——	5

No change during year now on Roll.

Active Members.

Published list of 1890 shows		345
Died between publication and Secretary's report, Oct. 1890	2	
Resigned during same period	3	5
Shown by Secretary's report, Oct. 1, 1890		340
Elected October 15, 1890	32	
Of which one did not qualify	1	31
		371
Resigned during year	3	
Dropped for non-payment of dues	13	
Died	7	23
		*348

Associate Members.

Number on Roll, by Secretary's Report, Oct. 1, 1890 (Agreeing with published list, 1890.)	15	
Elected October 15, 1890	7	22
Died during the year		1
Now on Roll, agreeing with published list, 1891		21
Total membership, October 1, 1891		374

MEMBERS WHO HAVE DIED DURING THE YEAR.

Active.

B. F. Sherman, New York, N. Y., Oct. 31, 1890.
Nathaniel Tufts, Boston, Mass., Nov. 9, 1890.
Wm. Mooney, New York, N. Y., Jan. 21, 1891.
Wm. H. Down, New York, N. Y., Feb. 15, 1891.

(*The published list of 1891 shows 350, as it includes the names of F. H. DeSaussure, who did not qualify, and the name of Samuel Prichitt, who died since publication of list.)

I. Linton, Ravenna, Ohio, March, 1891.
J. M. Sterling, Monroe, Mich., May 18, 1891.
Samuel Prichitt, Nashville, Tenn., Sept. 21, 1891.

Associate.

E. M. Russell, St. Louis, Mo., May 28, 1891.

ALEX C. HUMPHREYS, *Acting Secretary.*

PHILADELPHIA, Oct. 1, 1891.

REPORT OF THE (ACTING) TREASURER FOR THE YEAR ENDING SEPT. 30, 1891.

Receipts.

Dues for year 1889	$5.00	
" 1890	15.00	
" 1891	680.00	
" 1892	940.00	
		$1,640.00
Initiation fees—members elected Oct., 1890.		380.00
Payment in advance for 1891.		10.00
Sale of one set of "Proceedings"		9.75
Reports of meetings:		
Light, Heat and Power, Toronto Meeting.	$96.83	
" " " Baltimore "	24.75	
" " " Savannah "	82.00	
Amer. Gas Light Journal, " "	82.00	
Progressive Age, Baltimore "	24.75	
" " Savannah "	82.00	
		$392.33
Note discounted		300.00
Total receipts		$2,732.08
Cash brought forward from last year		418.84
Total to account for		$3,150.92

Expenditures.

Advertising:		
Light, Heat and Power, Baltimore Meeting,	$33.33	
" " " Savannah "	10.00	
Amer. Gas Lt. Journal, " "	20.00	
Progressive Age, " "	40.00	
		$103.33
Reporting Savannah Meeting..............		$246.00
Printing papers in advance, Savannah Meeting............................		259.75
Silk Badges, Savannah Meeting (bal. of acct).		30.00
Printing Circulars, etc., for Savannah Meeting....................................		56.00
Association Expenses at Savannah, Sec'y's.,	$233.40	
General,	104.29	
		337.69
Expenses of Secretary attending meeting of Council, in Louisville................		86.05
Stamps and stamped envelopes		156.98
Telegrams...........		34.86
Stationery................................		48.03
Initiation fee returned (paid twice in error).		10.00
Note paid		300.00
Interest..................................		9.30
Printing list of members, 1891............		30.00
Printing Circulars, New York Meeting.....		34.50
Wages—Clerks.		238.00
Salary of Secretary...............		600.00
Sundries..................................		55.95
		$2,636.44
Cash carried forward to next year......		514.48
		$3,150.92
Balance in First Nat. Bank of Phila..	$511.96	
Petty Cash.................	2.52	
As above....................	$514.48	

[redacted]

Due from Members.

For year 1888	$5.00	
" 1889	40.00	
" 1890	55.00	
" 1891	215.00	
" 1892	900.00	
Total		$1,215.00

ALEX. C. HUMPHREYS,
Acting Treasurer.

Examined and found correct.

A. E. BOARDMAN,
A. W. LITTLETON,
CHARLES H. NETTLETON.
Finance Committee.

NEW YORK, October 20, 1891.

REPORT OF FINANCE COMMITTEE.

The Finance Committee submitted the following report:

Your Finance Committee has examined the books and vouchers of the Secretary and Treasurer, C. J. R. Humphreys, and of the Acting Secretary and Treasurer, Alex. C. Humphreys, for the year ending Sept. 30, 1891, and has found the same to be correct.

A. E. BOARDMAN,
A. W. LITTLETON,
CHARLES H. NETTLETON.
Finance Committee.

THE PRESIDENT—You have heard read the reports of the Secretary, of the Treasurer, and also of the Finance Committee, upon the condition of the books and accounts. Is it your pleasure that they shall be received and placed on record? If there is no objection, such course will be taken. If any member desires to ask any questions in connection with those accounts, he now has opportunity to do so, as the Secretary

and Treasurer will be glad to reply, and to give any desired information. If there is no such desire expressed, we will consider that order of business duly closed. Mr. Secretary, what special committees are to report at this meeting?

THE SECRETARY—The Committee on the World's Columbian Exposition.

REPORTS OF SPECIAL COMMITTEES.

THE PRESIDENT.—The Chairman of that Committee is your President, Mr. Harbison, who is unfortunately detained at home by illness. The Committee has but little to report. As a member of that Committee, having made a visit to Chicago in this connection with Mr. Harbison, I am probably the only member of the Committee present who can tell you anything about it; hence, I may, in an off-hand report, tell you the position in which that World's Fair matter is: Your Committee met the officers of the World's Fair in Chicago, and found that there was no disposition upon the part of the commissioners to permit us to make there any extended or extensive display of gas as an illuminant. They would permit us, if we desired so to do, to erect a building (at our own expense), in which we might do anything we pleased that would not infringe the rules of the commission. They further agreed that all exhibits of gas appliances, of any nature, should be grouped as much as possible in one building, and that in that building we might make any exhibitions we pleased; but that the building itself would be lighted by the electric light. They assured us that the entire ground, and all the buildings, would be lit by the electric light, and by nothing else; that no gas lamps would be allowed, further than the privilege, if we desired, to exhibit one or more peculiar or novel street lamps, or large lamps for out-door service; they could be put up immediately contiguous to this building, but they would have to be subjected to any competition with the neighboring electric lights that were burning. In other words, they would not put out an electric light that might be in the neighborhood in order to accommodate these gas lamps. There seemed to be no disposition upon the part of the officers that we met to give gas any show there at all. They

are going to introduce one of the most magnificent electric plants in the world. Arrangements have already been made to that effect, and I think I may say without any risk of contradiction that it will be the most wonderful electrical exhibition that ever has been shown to man. Your Committee found that to be the condition of affairs, and could make no steps in the direction proposed, because the Committee were without power to act, and were sent there simply to find out what could be done. It struck both Mr. Harbison and myself that as this was to be the state of affairs, the matter had better be relegated to those who are engaged in the industry of producing gas apparatus and machinery, and, as they would be the exhibitors, they would really be the men to state what they wanted to do, and how they wanted to do it. It seemed to us idle to expect that the gas companies of this country would contribute a fund of money to be disposed of by us, as a Committee, or by anybody for the purpose of erecting a building there which should be specially devoted to the exhibition of gas in its various uses. The only recommendation that I can make from the Committee is that you receive this as a report from that Committee and dismiss us from further consideration of the subject; and then, if you wish to take up the subject again as a body, I would suggest that the next committee be composed of gentlemen in our membership who are actively engaged in the manufacture of gas apparatus. What is the pleasure of the Association as to the report of this special committee?

Mr. Slater—I move that the report of the committee be received and accepted, and the committee discharged.

Mr. Gates—With the thanks of the Association.

The President—I was very much afraid I was not going to be "thanked." You have heard the motion of Mr. Slater, duly seconded by Mr. Gates, that the report of your committee on the World's Fair, just made, be received, and that the committee be discharged from further consideration of the subject, with the thanks of the Association. Are you ready for the question?

Mr. Graeff—Does that mean that the matter is to be entirely dropped?

The President—The Chair does not so assume. The Chair simply understands that this committee is to be discharged, and another committee will be appointed in consonance with our suggestion.

Mr. Graeff—Is it the intention of the Chair—or the hope of the Chair—that a motion will be made to appoint such a committee?

The President—It is clearly the hope of the Chair that such action will be taken—as I feel we should have some central body to act for us—but that this committee be relieved. I think it was wrongly made up, and the committee itself so feels.

Mr. Graeff—I think so, too. (Laughter.) Does that motion include thanks to the committee?

The President—It does.

Mr. Lamson—I would like to ask whether the lighting of the Exhibition by the electric light is to be done under the control of electric light companies, or under the control of members of the commission?

The President—It is the unanimous vote of the commissioners that the whole place be lit by electrical appliances. We were informed that that was determined by a unanimous vote. So many of you as are in favor of receiving the report of the committee, according to the motion made, will please say aye; those who oppose, nay. It is unanimously carried.

Mr. William R. Beal, Chairman of the Local Committee of Arrangements, was then introduced, and he explained the arrangements which the committee had made for the entertainment of the ladies accompanying members of the Association.

Report of Committee on Nominations.

The President—If Mr. Cowdery, the Chairman of the Nominating Committee, is present and ready to report, we will next take up that report, nominating officers for the ensuing year.

Mr. Cowdery—I have the following report to make:

Your Nominating Committee would present the following candidates for election:

President—Wm. Henry White, of New York.

Vice-Presidents—A. E. Boardman, Macon, Ga.; W. H. Pearson, Toronto, Canada; Walton Clark, Philadelphia, Pa.

Secretary and Treasurer—A. B. Slater, Jr., Providence, R. I.

Council—Terms expire 1893—Jos. B. Crockett, San Francisco, Cal.; C. J. R. Humphreys, Lawrence, Mass.; John Young, Allegheny, Pa.; Irvin Butterworth, Columbus, O.

Leaving in the Council—terms expiring 1892—C. H. Nettleton, Birmingham, Conn.; Jas. Somerville, Indianapolis, Ind.; A. W. Littleton, Quincy, Ills.; F. Egner, New York City.

Your committee would have been glad to have presented to the Association for re-election, as Secretary and Treasurer, Mr. C. J. R. Humphreys, but it was known that owing to his severe illness and other reasons as previously explained by him to this Association, he would have been unable to accept.

Having thoroughly canvassed the field, your committee feels confident that in presenting the name of Mr. Slater, a competent successor to Mr. Humphreys has been nominated.

E. G. Cowdery,
Alex. C. Humphreys,
A. B. Slater, Jr.,
C. W. Blodgett,
Thomas Turner,
Committee.

ELECTION OF OFFICERS.

The President—The report of your committee placing in nomination the names for officers for the ensuing year is before you. What is your pleasure? The Constitution says that your

officers shall be elected by ballot, but by unanimous consent there can be one ballot cast. Do you desire to vote for these names, or will you have one ballot cast?

MR. RAMSDELL—I move that the Secretary cast the ballot of the Association.

THE PRESIDENT—It has been moved and seconded that the Secretary cast the ballot of the Association for the gentlemen whose names have been read. Is there any objection? The consent is unanimously granted, and the Secretary will cast the ballot. Mr. Graeff will oblige us by acting as teller.

THE SECRETARY—If I hear of no objection I shall give the unanimous ballot of the Association for the election of the gentlemen whose names you have heard read, to the several offices. Hearing no objection, I cast the ballot.

MR. GRAEFF—I have the pleasure of announcing that the officers named in the report of the Committee have been unanimously elected.

THE PRESIDENT—I have the pleasure of announcing the unanimous election of the gentlemen whose names you have heard read, to the several offices. (Applause.) I made no announcement of the condition of the health of our President, as I propose, in the few remarks which are set down as the President's address, to refer to that matter. Mr. Harbison will be with us to-morrow for a very brief time, if his convalescence has not been interfered with and the weather is good. His physician has permitted him to come; and it is his special request that he have the pleasure of presenting to you the officers elected. It will be the only duty that he can perform. Therefore, with your kind consent, the officers now elected will not be presented, as is usually done, immediately after election, but will be presented to you to-morrow by Mr. Harbison in person.

The Secretary then read an invitation to the Association, signed by the various exhibitors, to visit the exhibition of gas appliances in the basement of the Hall.

THE PRESIDENT—I desire to call your special attention to this exhibition, for it is well worthy your examination and is a very fine display of gas appliances.

OPENING ADDRESS.

The Chairman then said :

In the absence of our President, and in view of the shortness of the notice that I would be called upon to preside, I did not deem it just to the Association to attempt to prepare an address that should enter upon your records and go out to the public as the carefully thought out and deliberately delivered views of your Acting-President upon the important topics that are now engaging the attention of the gas engineer, and will receive your attention during this convention. The remarks I may make, in presenting the business to be considered, will be entitled, therefore, only to such attention as their impromptu character may call for.

In welcoming you here to-day I have to ask you to share with me the regret for the serious illness of Mr. Harbison, our President. I know you would much prefer that your chosen officer should have presided over you on this occasion. Early in September Mr. Harbison was taken with typhoid fever, and, as I am informed, has had a very serious time ; but fortunately his life has been spared, and, as I said a moment ago, if everything is favorable he will be with us for a brief time to-morrow. Mr. Harbison very keenly feels the deprivation he is suffering in not being able to preside over your deliberations. I know, from my association with him in committee work, that he has looked forward to this occasion with a great deal of pleasure. It is just and right that he should anticipate pleasure in the honor which you have conferred upon him, and that he should now experience a great mortification in this upsetting of his hopes and arrangements.

It is needless for me to say that I feel as you all do, how seriously we are crippled by the absence of our Secretary, Mr. Humphreys. With all respect to his brother, who has tried to fill the gap, and who has devoted many hours to straightening out our work, and given us an idea of how efficient a Secretary he could be, yet at the same time we must all of us feel great and sincere regret that Mr. C. J. R. Humphreys is not filling his accustomed place. It is with much greater regret that I say that his sickness has been a very serious one, and that it

was for a long time a question whether we should ever have our friend with us again. I am pleased, however, to be able to say that he is now making good progress towards recovery, and that it is the hope of his family, and I believe that hope is sustained by his medical advisers, that we shall have him with us at our next regular meeting.

I also feel it my duty to call your attention to the name of another devoted member of the Association upon whom the hand of sickness has been severely laid—a gentleman who has been with us at every meeting from very nearly the organization of this Association. When I say that Mr. William W. Goodwin is paralyzed, and is now lying at his home a cripple, I know that I shall find in your hearts the same feeling that is in my own—one of sincere and deep sorrow.

I would suggest, as these three gentlemen have all, in their several spheres, done much for the advancement of this Society, that a committee be appointed who shall, at our noon adjournment, prepare a telegram which may be sent to each of these gentlemen, letting them know in their homes and upon their sick beds that they are not forgotten by their brethren who are assembled here upon the business calling them together.

The Secretary in reading the report of the Council called our attention to the fact that our sadly lengthening list of the dead has grown rapidly in the past year. Oldest and youngest of our members have been taken away from us; and it was a very appropriate suggestion that from this time on, a separate page be set aside in our records for the names of those who have fallen in the ranks as the years passed by. Those of us who are growing steadily grayer and older, look back to the early struggles and history of this Association, and then to look at those who, with bright faces and younger hearts, are coming in to our membership, coming in more richly equipped than we were, and with advantages of education and stores of experience to draw from which were denied to us. We may feel that the work we founded will be carried on by strong and intelligent men. It is with great pleasure that your Council sees brought before it, year after year, the names of young men, active, well equipped, ready to carry on the burden of our professional lives, and the business of this Association. I will ask

you, the older members, to receive these young men with open hearts and open hands, and to give them of the stores of your experience. They may have a better understanding of the technique of the business; they may draw more finished plans than you and I, but they are sensible young men, and they know that garnered in the house of your experience there is wisdom and judgment, learned by hard knocks, that will be of great value to them. They will come to you for that experience, and I ask that you will give it to them willingly; for the great object of this Association is that those of you who have will give freely to those who need. These young gentlemen, while largely equipped in education, and filled with zeal and ambition in their business, yet are sensible boys, and they know that your old grayheads have something under time's snow, that crowns your working life, that is worth their digging up. Don't let them have to dig through any frozen crust to reach the hidden treasure they seek. Rather let it come out to them freely and willingly. I bespeak for these young men your heartiest greetings, your kindest and most courteous attention.

It is only necessary for me to say one word relative to the arrangements which have been made for our entertainment here, before committing the business of the meeting to your hands. As you will all remember, at the meeting in Savannah the Association, in its wisdom, passed a resolution declining to accept any hospitality, by way of banquets, from the cities they might in the future visit. They unfortunately added to that another resolution which practically directed the Committee of Arrangements to provide a dinner. Your Committee of Arrangements, in taking this matter up early last spring, felt that it was useless to attempt to get a dinner in the city of New York at a price which the Association would feel willing to pay. We have all been spoiled in the matter of dinners by reason of those which have been tendered us from time to time, and in place after place; and the modest luncheon of beer and sandwiches with which we opened the career of this Association will no longer suffice. No hotel in the city of New York is large enough (in addition to providing for its regular guests) to give us its dining room absolutely, and permit a body of 300 men or more to sit down to a banquet. Your committee, therefore,

felt compelled to get into business relations with the large catering houses of the city, and we found that it was simply impracticable to talk to them about getting up a dinner for the price which you would be willing to pay. The result would possibly be that half of you would go away from here without doing what we all like to do—putting our feet under the same table, and hearing the old chestnuts over again. In this dilemma, your committee decided to adjourn until after the meeting at Louisville, where the Council had been called together. There the matter could be considered, and the Council could instruct your committtee what to do. Such a meeting was held.

The committee presented its dilemma to the Council, and it was decided that the Secretary should be directed to send a circular note to the members of the Association, requesting them to say whether they desired to have a dinner at the hands of the gas companies in New York and vicinity—tendered to us as a matter of courtesy—or to have no dinner.

Of course, it is needless to say that Mr. Humphreys was a seriously sick man at Louisville, that he should not have been there, and was there only through zeal to discharge his duties. He left us to go upon the bed of sickness on which he now lies. He, therefore, did not send out those notices. His family were not allowed to talk to him about any business; his own brother was not permitted to see him for many months. Therefore, this notice was not sent out, but this Committee of Arrangements was not so advised until the time when it became necessary for them to take some action. On coming together they found they had no instructions from the members in regard to the dinner. They therefore took the bull by the horns, and found that our friends in New York and Brooklyn and Newark were not only willing, but indeed were quite anxious to furnish the necessary entertainment. We, therefore, broke one resolution, and tried to carry out the other. The gas companies of the neighborhood have tendered you a dinner, at the Manhattan Athletic Club, for Thursday evening, and a steamboat excursion on Friday afternoon. To that extent we have broken your rules and regulations. If you wanted a dinner there was nothing else for us to do. We presumed you did want a dinner—you do want a dinner, if we know you—and therefore

we accepted the offered hospitality in your name. If there is any censure to be offered, your committee stands here as a vicarious sacrifice. (Applause.)

There is nothing further for me to say beyond the statement that seven papers upon timely and interesting topics, which have been passed upon by the Council, are to come before you, and I heartily welcome you to an intellectual feast which I know will please, interest and instruct you. The gentlemen who have been invited to prepare these papers are all capable of writing well upon the subjects committed to them.

In this connection I would like to emphasize the remarks of the Secretary in his report, upon the absolute necessity of the gentlemen who are designated, or who consent to write papers, that they should write them promptly and early in the year, so that the Secretary may have ample time to print them before the meeting. If, 30 days ago, you could have had sent to you copies of the papers that are to be read here to-day and to-morrow, you can appreciate how much better equipped you would be to discuss them. You have at home data upon all these subjects, and you have there time to look it up, and to think it over. If you differ with the writer you can then have an opportunity to prepare yourself to debate with him. If you are favorable to his side of the question you can then come prepared to sustain him in any debate which may ensue upon the reading. In that way we would all get the benefit of the accumulated experience and wisdom of the members. You will all very readily see the value and necessity of conforming to the new regulation of the Council—that these papers shall be in the hands of the Secretary in time to be printed and delivered to you, or else a paper will have to take its chance, and be read as an individual manuscript, but without any preparation on the part of other members to discuss it. Our object is to get a high grade of papers. We have gone past the day of "rule of thumb" practice; the papers that are read here are also read abroad. They are not only read in this little room, but they go out to a very wide audience; and in this Association we can no longer take the risk of having papers crudely prepared, or our discussions as crude as the paper. Therefore, you must take time to properly prepare them, and take time to be ready to discuss them.

In conclusion, let me say that in discharging the duties devolved upon me in presiding over you, I simply rely upon the courtesy I have always had at your hands. I shall endeavor, as I always do, to be fair to every man. I ask you to assist me in expediting business as much as possible, and to see to it that there is no needless talk. I now leave the business of the Association in your hands. What is your pleasure ?

TELEGRAMS OF SYMPATHY.

MR. COWDERY—I move that a Committee of three be appointed to send telegrams of sympathy to the three members named by the President, and who are at this time too ill to be with us.

THE PRESIDENT—It has been moved and seconded that the Chair appoint a committee of three, to carry out the suggestion made by the Chair, to send telegrams in your name to our brothers Harbison, Humphreys and Goodwin. (The motion was carried.) I will appoint on such committee, Mr. E. G. Cowdery, Mr. Marcus Smith, and Mr. F. H. Shelton.

MR. PEARSON—I move that a committee be appointed by the Chair to recommend the next place of meeting.

The motion was agreed to, and the Chair announced as such committee, J. F. Scriver, T. Littlehales, John Andrew, Charles W. Blodgett and A. W. Littleton.

The Association then took a recess until 2 P. M.

FIRST DAY—AFTERNOON SESSION.

The Association was called to order at 2 P. M.

THE PRESIDENT—The order under which we adjourned was that of general business. There seems to be nothing on the desk of the Secretary calling for your attention. Does any member desire to present anything for the consideration of the Association before we take up the discussion of papers? If not

we will proceed to the next order of business, which is the reading of papers; and the Chair has the pleasure of announcing that the first paper to be presented to you will be one by Mr. Charles H. Nettleton. It is upon our old friend leakage—an ever interesting topic to us, and undoubtedly it will be treated in a very interesting exhaustive manner.

Mr. Nettleton (Birmingham, Conn.) then read the following paper on

LEAKAGE.

In presenting a paper on the subject of leakage, I do not expect to say anything startling, or to add very much to the stock of knowledge already possessed by the members of this Association, but as the subject is one that, "like the poor is with us always," and is one in which every gas manager is interested, I hope that my paper may not fall entirely on deaf ears.

The cost of gas is made up of so many items, that it is perhaps difficult to say which is the most important. The coal, the oil, the labor, the leakage, the office—they are all important, and care and attention should be given to each, but to no one item to the neglect of the others.

There used to be a saying current among gas men twenty years ago, that I have not heard so frequently in recent years, and that was "that the money was made or lost in the retort house," but times have changed, and now in many companies, a larger part of the cost of gas is outside the gas works yard, and "distribution" is as important, and in many cases more important than, "manufacture." In calling your attention to one of the items of distribution, "leakage," I am sure you will all agree that it is of sufficient importance to receive a portion of the time of every gas manager.

By the term leakage, I mean the difference between the gas registered at the station meter, and the amount for which we make out gas bills, plus the quantity consumed at works, offices, etc., in other words the unaccounted-for-gas.

The causes for the difference between the gas we make and the gas registered by consumer's meters are numerous, and some of them I propose to consider at length.

TEMPERATURE.

One of these causes over which we can have but little control, and to which I think but little attention has been paid is, the difference in temperature at which the gas is measured at the gas works, and that at the consumer's meter. A friend of mine tested the temperature of the gas for a year, in New York City at the Station meter of the works in his charge, and at the meter in his own house, and the average difference was nearly sixteen degrees. In this case the house meter was in the cellar. Allowing for meters kept in warmer places, such as factories, stores, etc., it is probably safe to say that in this latitude the difference in temperature of gas when made and when sold, is not far from 10 degrees, and as every 480 feet of gas expands or contracts about one foot for each increase or decrease of one degree in the thermometer, it follows that for the estimated 10 degrees, the contraction is two per cent., so that of our apparent loss of five or ten per cent., about two parts are beyond our control.

LEAKS IN MAINS.

The main source of loss, however, is probably leaks in mains and services.

Thanks to the energy and ability of the men who make our pipe to-day, we have, whether using cast iron, wrought iron or steel, an uniformly good pipe, in using which with reasonable care, good joints can easily be made. The younger men in the business, will never know unless they happen to use some ancient "special" the annoyance and bad language that was produced years ago, by the spigot end of some fitting being too large for the hub of some pipe of the same nominal size, though both pipe and special, perhaps, came from the same foundry, or when in regular hub and spigot pipe, the space for a joint was only one-eighth of an inch in width. With such pipe it was very difficult to make good joints, and consequently difficult to keep down the leakage.

I am unable to speak from personal knowledge of the use of wrought iron or steel pipe as mains, but those who have used that kind speak highly of it, particularly in connection with its

freedom from leaks. The company with which I am connected have nothing but hub and spigot cast iron mains, and as they in this section of the country, are used almost exclusively, I propose to confine my remarks to them alone. Owing to the heavy water pressure put upon all cast iron pipes at the foundry where made, the pipes when first purchased are almost certain to be without cracks or holes, and when laid and the joints well made with either a good soft lead or Roman or Portland cement, one is reasonably sure of having a tight pipe before the ditch is filled.

In regard to material used in making joints, personally I prefer those made of cement, on the score of much less cost, and less liability to leak. A personal experience, which is no doubt familiar to many of you in your own work, will best illustrate my faith in cement joints. In a severe winter several years ago the frost had gone down around a six inch gas pipe on a certain street and a large leak was reported in that neighborhood. On digging up the pipe it was found to have pulled apart three-eighths of an inch where tapped for a three-quarter inch pipe, and a cement hub and spigot joint less than three feet away was intact. I think the chances are that with a lead joint the latter would have drawn and a leak started which would not have been stopped until the "smelling committee" (as named by one of our local papers) had put in its work. But either lead or cement with well driven gaskets make a first class joint.

The filling of the ditch as far as the top of the pipe is a very important matter, and too much care cannot be taken up to that point. Crooked rammers should be used to pack the dirt firmly and solidly under the pipe, so as to give it as solid a foundation as possible. But in doing this care is needed, particularly with small pipes, to see that the dirt is not rammed too vigorously, thus raising the pipe out of line and making the first start toward leaky joints. I desire to emphasize this point, as I believe as much or more depends on the way the ditch is filled, as on the way the joints are made. Another personal experience may illustrate this.

About twelve years ago, when knowledge seemed to be much larger in quantity with the speaker than at the present time, I had occasion to lay about 8,000 feet of eight-inch pipe. It was

rushed through, and the cost per foot was satisfactorily small, the gas was turned on, and tested by means of a meter and valve. To my surprise and mortification the gas was going through the meter rapidly, although not a consumer was on the main. Some of the leaks were soon found and stopped, but the pipe could not be made satisfactorily tight at once. Afterwards I found out that in the hurry of getting in so many lengths of pipe per day, that in certain sections the dirt had not been properly rammed under the pipe. For nearly three years after it was laid it was a source of great annoyance and expense, but finally, with the ramming that each length received when a leak was repaired, the trouble disappeared, and to-day it is as tight as any other length of main under my control. But while the trouble lasted I believe it is no exaggeration to say that more than 500 leaks were repaired on that line of pipe. Since that time my attention in laying pipe has been given principally to packing the dirt under and around the pipe.

KIND OF SOIL.

The quantity of leakage depends to a considerable extent on the character of the soil surrounding the pipes. Given, a sandy or gravel soil, and the passage of the gas from the pipe through a hole or a cracked joint, is hindered very little by the surrounding dirt; loam lessens the leak materially, and stiff wet clay makes the pipes tight, holes and cracks to the contrary notwithstanding.

In a certain city in which the gas pipes are surrounded by mud, through which the gas cannot be forced by the ordinary pressure, I was told, that the leakage was absolutely nothing except the gas lost in making connection with services, laying new mains, etc.

In this connection it may not be out of place to describe the method followed by the speaker in searching for leaks. The gang is made up of a foreman and either eight or ten men. The foreman from his book containing the location of pipes, lays out the line of pipe, indicating same in any convenient manner. Along this line, when on unpaved streets, a man makes holes every six or eight feet through the crust of the road with some

light pointed iron bar, generally a piece of one-inch pipe with a steel point at one end.

Following him come six or eight men in couples, each with an eight pound striking hammer, and each couple with a steel bar about 3 feet 6 inches long, having one end drawn out to a long, sharp tapering point. In the shallow holes made by the man in advance, these steel bars are driven, each bar being struck by two hammers. When driven from two to three feet, the distance varying with the known depth of the pipe, the bar is hammered sideways, and then is easily withdrawn by hand. The two men take their bar and go forward immediately to drive another hole.

Following these, is another man, whose sole business is to smell at the openings made by the bars, and then fill in the same with loose dirt, reporting all leaks to the foreman.

On paved streets, the same bar is used for a short distance to separate the paving blocks and then a smaller bar is driven down to the main. So much difficulty was found however in withdrawing the bars on paved streets that to save time a tool was made, which, while crude, works well. A heavy bar with jaws on one end is used as a lever, a piece of hard wood cut on edge into steps, the latter shod with iron plates is used as a fulcrum, and the bar pried out. This simple device nearly doubled the amount of work that could be done on paved streets with a given amount of labor, as compared with withdrawing the bars by hand.

The above system is the result of many experiments through a series of years, and while it may not answer in all places, yet with the soil in my neighborhood, which is largely sand and gravel, it works very well.

SERVICES.

With leaks in services, I have had very little experience, but I am told that in older companies than mine, and in those where the soil rusts wrought iron quickly, this is a large source of loss.

It is said that this destruction can be prevented by coating the pipe with one or more preparations, but of that I cannot speak of my own knowledge. Certainly, if troubled from this

source, I would try to see that the services were so coated that little or no rust would form.

CONSUMERS METERS.

Another cause of unaccounted for gas is the errors in consumers meters, for which I think the only remedy is periodical testing. If a company does not test its meters for years, some of them are bound to get out of order, the bellows gradually lose their oil, do not expand to their full capacity, and the meters run fast, or the bellows are cracked, the valves or their seats wear unevenly, and the meters run slow.

The fast meters, when they become fast enough, are sure to be heard from, by reason of complaints from consumers, are brought in, tested, and correct meters substituted ; but the slow meters are rarely heard from, generally not until they fail entirely to register. In this way, and for these reasons, a company failing to test its meters will in time have a large majority running slow ; and I am confident, after testing all my meters a number of times, and knowing how many run fast and how many run slow, even when repaired every three or four years, that it is only a question of a few years before seven per cent. or even more of all gas sent out would become "unaccounted for" by reason of slow consumers meters.

This is one reason, but not the only one, why it pays to test meters periodically.

STATION METERS.

Another cause of loss is an incorrect station meter. How general this is I am unable to say, but more than once when hearing some wonderful tale of big yields per pound, I have wondered if the station meter on which these results were based was correct. I have heard it stated that very large yields and very large leakage were quite apt to go together. But in this matter, as in many others, it is very easy to deceive oneself, and tests should be made occasionally to demonstrate the fact that the meter is approximately correct.

The following table has been prepared with care, and gives the results obtained at the works in my charge for the past ten years.

Year Ending.	Gas Sent Out.	Unaccounted For.	Per Cent.	Miles of Pipes (Approximate.)	Sent Out Per Mile Per Year.	Lost Per Mile Per Year.	Total Cost of Searching and Stopping Leaks.	Cost Per Mile. Per Year.	Yield per pound of Coal.
April 1, 1882	20503040	1879082	9.1	9.4	2181174	199902	$862.23	$91.72	4.72
" 1883	24331210	2007518	8.2	10.6	2295397	189388	273.21	25.77	4.90
" 1884	27770260	2659308	9.5	11.8	2353412	225365	285.64	24.21	4.87
" 1885	26471990	2216838	8.3	12.2	2169835	181708	481.20	39.36	4.93
" 1886	28332044	1496123	5.3	14.3	1981262	104624	395.63	27.66	4.92
" 1887	30107386	1539296	5.1	14.8	2034350	104006	609.79	41.20	4.74
" 1888	33268912	1533448	4.6	15.3	2174439	100225	22.74	1.48	4.91
" 1889	34851118	1859938	5.3	15.8	2205767	117718	531.04	33.61	4.89
" 1890	38910268	1679948	4.3	16.7	2329956	100595	243.42	14.57	4.85
" 1891	43001890	1154021	2.7	16.9	2544490	68285	370.61	21.93	4.77

The first column is the gas sent out for the several years as stated.

The second column, the unaccounted for gas expressed in feet.

The third column the unaccounted for gas expressed in percentage of the total send out.

The fourth column, the miles of pipe. I regret to say that the figures for the first few years are not absolutely accurate. The errors, however, I believe to be slight. The figures for the last four years are correct.

The fifth column, gas sent out per mile of pipe per year.

The sixth column, the loss per mile of pipe per year. This probably expresses leakage in the fairest way possible for the purpose of comparison with other works; and yet given a works with a consumption of ten millions per mile, and the loss due to difference in temperature at which gas is measured at works and in consumers' houses would probably be nearly 200,000 feet per mile. For the averaged sized works, however, under one hundred millions per year, and sending out between one and one-half and three millions per mile of pipe per year, I suggest that no fairer basis of comparison can be made than the feet lost per mile per year.

It was suggested a few years since that the size of pipe ought ot be considered; that on a twelve-inch pipe the chances of a leak were just double that on a six-inch, owing to the greater area of pipe and joint. But all smaller works will average about the same sized pipes, and to figure everything to a basis of say a 4 inch pipe, is a refinement that in my judgment is uncalled for. I am quite well satisfied that for small works 100,000 to 150,000 feet per mile per year should be considered a reasonable amount of leakage, and unless the circumstances were exceptional, a manager should not rest satisfied until that figure was reached.

Seventh and eighth columns give total cost and cost per mile respectively, of searching for and stopping leaks. These columns are added to add general interest to the table and in the hope that the discussion will bring out the fact that the costs stated are above or below the average cost in other places.

I desire to call your attention to the fact that in the year ending April 1st, 1888, but $22.00 was charged to leakage, but in

the year following quite a large amount was spent and yet the leakage increased, showing the lack of attention in the previous year.

The ninth column is added so that it cannot be suggested that if the yield per pound of coal had been given, the table might have assumed a different appearance. It is but fair to state that these yields are reached after adding two per cent. to the weight of coal carbonized. Your attention is called to the lower yield for year ending April 1st, 1891, and the small leakage in the same year. I think it is entirely probable that if the yield for the last year had been larger, that the unaccounted for gas would not have been so small as reported.

In closing this paper I venture the opinion that like many lines of work it requires only patience and perseverance to make a success with the leakage problem.

Regular attention, the same we give to our manufacturing operations, through a series of years, will certainly bring the desired result. But when once reduced it will not do to assume that the leakage will remain small; the laws of nature are constantly working in a way that must produce leaks sooner or later, and if no attention be paid to mains for two or three years the leakage will surely increase no matter how small at the commencement.

I heard one of the best known and most successful lawyers of this country say, that the conditions of success in his profession were a good stomach, a willingness to work, and a very moderate amount of brains. However much one may be inclined to take the remark *cum grano salis*, as applied to the legal profession, there can be no question as to its truth when applied to successful work on leakage.

A good stomach—health to attend to the work and strength to do it.

A willingness to work—industry and perseverance, a determination to reach the goal you have set for yourself if work will accomplish it.

A moderate amount of brains—I have yet to discover the need of any considerable ability in trying to reduce leakage. We are all, the brightest man, and the dullest, on about the same level when it comes to the treatment of this question.

Work, and work alone, is nearly all that is required. "Eternal vigilance is the price of liberty." Everlasting effort, the price of small leakage.

Discussion.

THE PRESIDENT—You have heard, I have no doubt, with great pleasure, the reading of this very bright and capable paper. If any gentleman wishes to ask any question on the subject, I am sure that Mr. Nettleton is prepared to answer. The Chair desires to have some discussion on this very important question.

MR. A. E. BOARDMAN—I would like to ask Mr. Nettleton why he adds 2 per cent. to his total weight of coal in estimating his yield. Is it because he finds that more is used, and that that is the amount of error; or is it a custom in that section of the country?

MR. C. H. NETTLETON—Before I added a percentage to the quantity of coal actually weighed into the retort the coal pile ran short each year. I think I commenced by adding 1 per cent., but found that that was not enough; I then added 2 per cent.; and the last time I balanced the coal the error was a very small fraction of 1 per cent. I presume the shrinkage comes in the amount of water contained in the coal, which evaporates before the coal is used; and also is due to errors which the retort house men are bound to make in weighing in the coal. This practice I have continued for about ten years.

MR. A. E. BOARDMAN—I asked this question purposely in order to bring out that statement. I think that most of us have experienced a difficulty in making our coal account balance; but I find, contrary to the experience of Mr. Nettleton, that my coal pile is apt to be over rather than under weight, owing to the fact that my retort house men will fill up the barrow, weigh it on the scale, and then if their heats are a little low they will leave off a shovel or two, and that shovel or two of coal goes back on the scale and is weighed. So that at the end of the year I really have more coal than I ought to have. I am glad to find that Mr. Nettleton's men are a little more conscientious.

Mr. J. F. Scriver—I think that Mr. Nettleton is to be congratulated on his very low percentage of leakage. I think that most gas men present would feel somewhat envious of Mr. Nettleton's results. But there is one very fruitful and frequent source of leakage to which Mr. Nettleton has not referred in his admirable paper, and that is the one of condensation. With us who are further north, I think that is one of the greatest sources of unaccounted for gas. The question of condensation is a very serious one with us, and one which we cannot, of course, according to the nature of events, overcome. I would like to hear from Mr. Nettleton whether he is troubled at all with condensation in his pipes.

Mr. C. H. Nettleton—I shall have to ask Mr. Scriver just what he means by condensation. Do I understand him to include in that the difference in temperature at which the gas is measured by the meter at the works, and the temperature at which it is measured at the consumer's meter? Is not that the principal source of what is called "condensation?" Of course, there are some liquids which condense out of the gas, which undoubtedly exist there in the form of vapor and which were measured at the station meter; but I think that is but a small part of the condensation. I pump very litttle out of my mains. The drips, except a few near the works, are pumped only once a year, and the quantity obtained is not large. I think that the principal condensation is due to the difference in temperature between which the gas is measured at the works and that at which it is measured at the consumer's meter. I may be wrong, however, in that idea.

Mr. T. Littlehales—I would like to ask Mr. Nettleton for his experience as to gas passing through large meters. In my own experience, in the case of a large number of dry meters of large size, say 50, 80, or 100-light meters, where they let one or two burners go all night, I have found a very marked source of leakage from that cause. Gentlemen will readily recognize that fact when they recall that the slightest bit of corrosion, or if a particle of dust gets under the valves, leaves a very large area open for the gas to escape. As an illustration of that, I took out a 50-light meter not long ago, and with three lights

only it would not register a foot; with five lights it was 75 per cent. slow, but yet with 50 lights going it was practically correct. I am perfectly satisfied that in a great many cases where we have large meters with one or two lights going all night, we lose a great deal from that source. It is important to know if anything can be done to obviate that difficulty.

MR. C. H. NETTLETON—I try to avoid that trouble, which is bound to occur with many large meters by bringing in and testing every large meter we have once a year. I think in that way we avoid much of the loss due to non-registration. All my meters are ordinarily tested every three years, but all the large meters and all meters in factories where there is a large consumption, are tested every year.

MR. T. LITTLEHALES—You have found that error frequently to occur, have you?

MR. C. H. NETTLETON—Yes.

MR. W. H. PEARSON—I was under the impression that we were losing a great deal of gas from the source that Mr. Littlehales has just referred to, but about a year since I sent an inspector to every place where there was a large meter and had, I should suppose, 400 or 500 of these meters examined, and tested with a single light, and I found that out of that number there were not six meters which would not register with one light. I must confess that I was very much surprised at the result of that test. I expected a very different result. I do not now think that there is very much gas lost from that cause.

MR. GEO. B. NEAL—When the Chair called for remarks from members upon this subject, I thought that all the members present would rise to their feet, and that it would be impossible to hear and understand what anyone said, for there would be so many talking at once. But, when there was a pause I began to think that most of the leakage experienced in other companies was very small—but a trifle in fact. In the company which I represent, the Charlestown Gas Company, we have had a leakage year after year, and I have made the greatest exertion to find where those leaks were and to stop them. With that end in view I have used meters with a good many valves

and by-passes; but the leakage does not go down. I should not be quite so sensitive on that subject but for the fact that under the laws of Massachusetts I am required to make a report, and which report is read all over the country. In fact I understand that the reports of the Commissioners are considered such interesting reading that they are sent all over the civilized world. We have one of the Commissioners here to-day, and he can corroborate my statement. These reports are, indeed, very interesting reading. In New England we have to show our candle power; and it is very unpleasant for me to see in print the statement which I have to make that the leakage is 10 or 12 per cent., as the case may be. I have tried my best to reduce the amount of leakage, but have not succeeded. So far as testing meters is concerned, I think that the average of those that are sent to the inspector for testing are very nearly correct. Many are slow, and as many are fast. Some time ago the leakage in one quarter came down 33 per cent., but I was not conscious that any leaks had been stopped. We had done nothing in particular to cause that change. This last quarter, from April to July, there was the same diminution in the amount of leakage—about 33 per cent., and I cannot account for it in any possible way. I wish that the gentleman who read the paper could have suggested some remedy, some strong remedy, that we might apply in a very violent way, by which we could reduce that leakage. I do not think that it is caused by excessive measurement on the part of the station meter. In fact, I am very sure that it is not, because last year, during most of the year, the yield was not five feet per pound. I think that this is not the trouble. I am satisfied of this, however, that sometimes it is owing to leakage in the joints where the spigot end is too large. That happened to me some years ago in a 12-inch pipe that was extended about a mile. We had leakage after leakage from that cause. But that was all stopped. We have two districts, one of which is composed mostly of consumers in dwelling houses, and there the leakage is comparatively small; but in Charlestown the leakage is quite large. There is one point as to which I do not quite agree with the writer, that condensation is greater in cold weather. I do not know as that has been stated exactly that way, but as I understand it that is

what is meant to be implied. I do not see but what the condensation with us is about the same in summer as in winter. Supposing the gas was delivered at a given temperature, and was measured at the station meter and then delivered at the consumer's meter at the same temperature, do you think there would be no loss in that respect from shrinkage in volume? But, suppose that we allow the two per cent. which you have allowed, and then after passing the gas through the consumer's meter, let us pass it through another meter, and then raise the temperature to what it was in the station meter—would there then be any loss from that source?

MR. C. H. NETTLETON—But little or none. Of course what is pumped out of the pipe represents so much lost.

MR. GEO. B. NEAL—I thought that you would reply that the gas in passing through the station meter occupies a certain volume, and then when it gets to the consumer's meter it is colder, and that the same gas exactly shrinks in volume. There is no condensation there, is there? I think there is not, because as soon as you restore it to the same temperature it was in the station meter it again occupies the same volume that it did before.

MR. C. H. NETTLETON—It depends upon what you mean by "condensation."

MR. GEO. B. NEAL—Condensation, as we all understand it, is where some of the gas is deposited in a liquid form in the drips. I wish some remedy could be devised for that. The Charlestown Gas Company suffers from that, and greatly to the injury of its reputation, because everybody reads that report, in spite of all my efforts to the contrary. I think Mr. Miller has tried very successfully this plan of testing meters at the residences of consumers—not taking the meter away, but having them tested at the house. I would like to hear from him on that subject.

MR. A. S. MILLER—I think when the gas leaves the station meter it is practically saturated with watery vapor, and so for each degree of contraction the diminution in volume would be very much greater than in the case of perfect gas, and that

there would be a very large amount—not of shrinkage, as Mr Nettleton puts it, but of actual condensation of the liquor. So that if you pass it through your consumer's meter 10° below the temperature at which it passes through the station meter, then heat it up 10° again, and then put it through another meter, you would not get all the volume, by a good deal, that you had to begin with. Of course, there is a great deal of actual condensation whenever the temperature is reduced. Another thing: My experience has not been with a great many station meters, but I have found when a station meter is tested by running through 300 or 400 feet per hour, the water line being very carefully kept constant, and then put into use at anything like its full capacity, the motion of the meter would run the water out, or overflow it, and although the water would show high on the glass, yet if you stop the exhauster and allow everything to become normal the water in the meter would actually show below the correct water line as shown by the gauge. In other words, the pressure of the gas inside of the drum would throw the water out of it, piling it high up on the outside, and leaving it low inside the drum. The water would apparently be high, and yet the meter would be registering slow.

MR. A. E. BOARDMAN—I would state I think we are in error when we try to calculate or estimate that condensation of watery vapor out of the gas changes its volume much. I do not think that the watery vapor contained in gas adds greatly to its volume. I think the molecules of water occupy almost exactly the same space and lie between the molecules of gas. So that condensing and taking out the liquids would not reduce the quantity of gas under a given temperature to that degree that we usually imagine. In regard to station meters and consumers' meters, I would call your attention to the fact that in a large majority of cases the gas as measured in your station meter is under 2½ to 5 inches pressure, while it is distributed to your consumers' meters under a pressure of from ½ inch to 1½ inches.

MR. A. S. MILLER—I cannot go deeply into the subject of watery vapor, but Mr. Boardman will find it worked out in the second volume of "King's Treatise," and that will convince

him that the presence of watery vapor in gas does make a very great difference.

Mr. A. G. Glasgow—About this matter of vapor condensation: The fact that gas containing aqueous vapor occupies a larger volume than the same gas desiccated can be readily demonstrated in the following way: Into a vessel containing perfectly dry gas at, say, atmospheric pressure, inject a quantity of water, not exceeding that necessary to saturate the gas. The whole of the water will vaporize, and will, therefore, as water, occupy no volume; but the pressure within the vessel will rise above atmospheric, showing a corresponding increase in the volume of the gas and vapor. This is a standard experiment in physical laboratories. Mr. Nettleton, in his paper, has made some observations upon main laying. With one of these I do not find myself in sympathy. He lays especial stress upon the importance of thoroughly ramming the earth back *under* the pipes. If you excavate the earth below the line of the bottom of the pipe you should certainly ram it back as carefully as possible; but why make this needless excavation? It has never been clear to me why so many people, in laying mains, habitually dig the trench deeper by 6 or 8 inches than the pipe is to go, then raise the pipe to its approximate elevation by throwing loose dirt under its bell end, bringing it to its true grade by dropping its free end several times upon this little pile of earth. Such a method not only entails the needless cost of excavating and refilling this additional earth, but, what is of even more consequence, the pipe is resting upon what may, to a certain extent, be called "made" ground. During my connection with a growing Western city we laid a great many miles of pipe, from 24 inches to 4 inches in size, and followed the invariable custom of grading the bottom of the trench to receive the pipe fair upon it—with the exception of the carefully located excavation of the joints—thereby saving money and doing a better job.

Mr. W. P. Fodell—With reference to this matter of filling, I may say in our case it has been the habit to lay a piece of plank under the pipe, on solid ground, and then the earth is filled in around without any tamping. With reference to the kind of soil, I may say we find that a pipe laid in gravelly soil

oxidizes very rapidly, whereas pipe laid in loamy soil (where the loam touches the pipe) is almost as good as new when it is uncovered after a long period. With regard to meters, I may say when we find that a man's bill is gradually getting smaller we change his meter, and then we ordinarily find his bill going up to the usual amount. In regard to condensation, we take the temperature of the gas as it leaves the station meter, and also take it at the extreme end of the district, and find that the difference in temperature is so small that the percentage is hardly worth mentioning.

MR. GEO. T. THOMPSON—If a long discussion is any criterion of the value of a paper, Mr. Nettleton must be much gratified. Before the discussion is closed I should like to ask him a question. Does he have any system of districting by which he can localize his leakage, or does he simply distribute the leakage over the entire area?

MR. C. H. NETTLETON—I have for several years gone over all the pipes. Some ten years ago in certain districts valves were inserted, and then the mains were tested by shutting off certain lines and passing gas into them through a meter. But as the number of consumers has increased it has become unsatisfactory; for it was uncertain, in putting a meter on a certain length of pipe, that there were not one or more burners going, or that there were not one or more gas stoves in use. I presume my experience is similar to that of other people in that respect.

MR. F. W. GATES—How often do you think it is advisable to go over your mains? For instance, if you make an examination this year, what interval would you think it safe to allow before you examine them again?

MR. C. H. NETTLETON—I now go over the mains once every year. When the leakage was up to 9 or 10 per cent. I went over them twice generally in one year.

MR. JAMES SOMERVILLE—This statement by Mr. Nettleton of 2.7 per cent loss by leakage seems to be so extreme that I would like to hear a little more about it. When I got my leak-

age down to 7 per cent. I thought I was doing remarkably well. Is it all coal gas that you make?

MR. C. H. NETTLETON—Yes.

MR. JAMES SOMERVILLE—Do you have many public lamps?

MR. C. H. NETTLETON—None at all.

MR. SOMERVILLE—Do you bring your gas to a standard temperature?

MR. C. H. NETTLETON—No; we do not. In winter the temperature is about 60°. In summer the temperature is that of the surrounding air, and probably averages between 70° and 80°.

MR. JAMES SOMERVILLE—A difference between the station meter and the consumer's meter of 2 per cent. is practically no leakage at all, as it seems to me. This reminds me of some one here who once stated at one of our meetings that he sent out more gas than he made. I remember that George Anderson, a London gas engineer, in speaking of this very subject of leakage, stated he was supplying a large quantity of gas to the authorities, that he measured his gas from the station meter into the holder and charged for the gas so measured, but the authorities rejected that measurement and ordered him to put a station meter outside of his works, declaring they would only pay for gas as measured through that meter. He complied with the request—he had to do it—and the difference between the two meters in that short space was 5 per cent. Between the meter in the works and the meter outside of the works there was a loss of 5 per cent. I think you might well put in another 2 per cent. as the difference between the station meter and the consumer's meters. Thus you would have about 7 per cent. of unaccounted-for gas. Now, there is always some leakage going on. I have often amused myself with my specific gravity apparatus by laying my glass globe right upon the scale. This glass globe is as empty as human ingenuity can make it, and yet in a few minutes you will generally see the scale gradually go down. What is it doing? The air is going into the globe and gas is getting out of it. That extraordinary law of endosmose is displacing the gas, and it is going out. If you

shut off a gas meter, when you turn the gas on again you will find that a little air has gone in; the gas and the air have changed places. With these facts before me, I cannot understand this 2.7 per cent. I advise those men who are troubled as much about it as I am, not to get down-hearted at losing so much gas. I fancy somehow or other that with this make of gas of 4.77 feet per pound, it is just possible that the station meter was not just right.

MR. WALTON CLARK—I think I misunderstood Mr. Nettleton's statement, for I understood him to say that he goes over his mains once every year, but he says in his paper that he drives his holes 6 or 8 feet apart (which would be 600 or 800 to the mile), and that in the year 1890 the cost of this was $14.57 —to drive those holes and to do whatever digging was necessary--per mile of main. Have I misunderstood Mr. Nettleton in that respect?

MR. C. H. NETTLETON—No.

MR. WALTON CLARK—Then Mr. Nettleton spends but $14.57 per mile for driving between 600 and 800 holes, which I think is marvelously cheap work.

MR. W. R. ADDICKS—I am always deeply interested in the subject of leakage, and I have here some reports of the testing department of the Boston Gas Light Company for the last six months, from January to July, 1891. Our method of testing is by valves. In starting out to work, with 140 miles of main, the question was where to begin. We selected the worst districts and put our meters in them, thus only taking up sections where the leakage seemed to be greatest. The number of tests made from January to July in the test department (which consists of a man and two helpers, and when the one in charge is not at work testing mains, he is oiling valves and keeping them in good condition) was 237, and the amount of pipe tested was 173,882 feet—approximating 32 miles. The leakage on this test was 357 feet per hour. After barring the districts that showed leakage, the meter tests proved the loss to be only 63 feet per hour—making a net gain to the Company of 294 feet per hour for the number of miles tested. We are continuing

that policy now. Presuming that the remainder of the system will average about the same as the 32 miles, then, in the 140 miles of the system, the leakage will approximate 20,000,000 feet of gas per year. We have already stopped the escape of 3,520,000 feet per year during the six months from January to July. This does not include leaks reported to the gas office. I have a list of all the leaks reported to the gas office from 1854 to date. I think in 1854 about 154 leaks were stopped during the year—this refers to the main department alone, and not to the service department. Last year some 300 leaks were reported to the gas office, and the total number of leaks stopped amounted to 1,298. Up to October 1st, of this year, we had found 1,863 more. If we keep that record up for the next three months, the same as last year, the number of leaks found in Boston proper will amount to 2,300, making a total for the two years of 3,600 leaks—which are as many as the leaks reported to the gas office and stopped during the years 1876 to 1889, inclusive. Of course, we always have from 200 to 400 leaks reported to the gas office, and those, unfortunately, come in the winter months. Comparing the number of leaks, we find that in June, July and August there are from no leaks up to five or six; and of course leaks found in the winter are very much more expensive to find than those which we hunt for in the summer. That is one source of leakage, and I estimate approximately 20,000,000 feet for Boston proper. Now as to the question of meters: Mr. Neal has referred to the fact that the Boston Gas Light Company started out to test every meter on the consumer's premises. We gave that up after two months trial. One of the helpers in going down a trap door in a store, unfortunately, left it open, and it cost the Company $11,000 for that little repair. So from that time on we have not tested any more meters on the premises of the consumers. We now remove the meters by districts. Last year we removed 9,000 meters, without much system about it, except that we went where the consumers' bills were small; but we are now taking them by districts, removing them systematically, leaving those which were put in within a year and a half, and which we know are correct. The State Inspector reports only gas meters fast, slow and correct, and as I felt that in order to answer the ques-

tion whether it pays to do this work, something more ought to be given, I had a table made up. I have before me one of the monthly tables, which includes not only the fast and the slow, but also indicates the percentages of fast and slow. It is perfectly manifest that a three-light meter non-registering, should not have the same value as a hundred-light meter non-registering. In the three months of July, August and September, we removed 873 meters. Of those 549 were correct, 89 were fast, and 235 were slow. Then we took each meter and multiplied it by the number of lights. For instance, if we had 10 ten-light meters, we would multiply the ten lights by the ten meters, which would give us 100 lights, and being the equivalent of one 100 light meter. That gave us some idea of the number of lights fast or slow. In other words, the results were reduced to 1-light meters, 1 per cent. fast or slow. This involved a great deal of work, but not so much as it would to move the meters when it was not necessary to do so. The results were as follows: In July 8,014 1-light meters were 1 per cent. slow over and above those that were fast—that was the difference between the two, there were more slow than fast. The difference between the two was 8,014 1-light meters, 1 per cent. slow; in August there were 6,081; in September, 5,138, making a total of 19,233 1-light meters 1 per cent. slow. That is equivalent in removal to 773 meters, or 3 per cent. of the meters we have in use. On the supposition that all the meters are equally bad and equally good in the various districts, that would be, then, for the whole district, 641,100 1-light meters 1 per cent. slow in Boston proper at the present time. We have altogether in Boston 315,000 1-light meters. That is without any reference to the percentages fast or slow. If a meter was 100 per cent. slow, then that, of course, would be multiplied by 100. That is the reason why the present fast or slow seems so large—641,100. Dividing 315,000 meter lights into the number of feet of gas sold through the consumers' meters, the average amount sold was 3,800 per meter light in Boston per annum. That represents a leakage, considering that the figures hold together, as far as the average fast and slow is concerned, of about 24,000,000 feet per annum leakage through the meters. I do not mean to state that these figures will hold out accurately. I merely say

they are hints as to what I believe is going on. Now, as regards the third question—of leakage by condensation. The Roxbury Company, before the works were closed, made their own gas, and their leakage was 8 per cent. They are now purchasing gas through a line of mains approximating 2½ to 3 miles from the source of supply, and their leakage to-day is but 2 per cent.; and you can fairly charge at least a portion of this difference between 8 and 2 per cent. to the apparent leakage on account of condensation. The semi-annual reports by the Roxbury Company in the test department—and the amount tested there is comparatively small—show that in six months the leakage before barring was 126 feet, and after barring it was but 17 feet. There was a net gain of 109 feet per hour. I find that in Dorchester and Roxbury a mile of main will only show a leakage of from 1 to 5 feet per hour. In Boston proper, where there is a great deal of made ground, and a great deal of digging, of course the condition of the main is not so good. Now, as to how to maintain that efficiency. Every test is entered on a ledger which has 8 or 10 lines devoted to one single valve, and the record of that valve is placed on top, at the first test (we endeavor to get a test every year), and the record of each test appears immediately under the previous test. In that way we can see, without going out with the bar at all, whether the condition of that main has deteriorated. That saves all barring, and there is no barring whatever done unless the test department indicates a necessity for it.

Mr. F. H. Shelton—I would like to show how Mr. Nettleton's figures support one or two of the points which have been made with reference to temperature; and I want to show to how small an extent what we term "condensation" amounts in cubic capacity. I do not know in what way the dictionary defines condensation, but to a gas man I think it generally means the quantity of liquor that is deposited in the mains or drips; and that "shrinkage" properly expresses in a gas sense the difference in volume due to temperature and contraction. Mr. Nettleton has drawn our attention to that. He has shown us that on every mile of pipe under his charge there is a leakage of over 68,000 cubic feet per year at present, and that eight or

ten years ago the loss per mile per year amounted to nearly 200,000 cubic feet. He gets from his drips on his lines practically nothing. He may get a few gallons occasionally. I will ask you to figure out the small percentage that a few gallons of condensation would amount to on the total amount of gas passed through the main, or even the total amount of leakage. I think that in Mr. Nettleton's case it is so small that we can safely and properly claim that the loss is from shrinkage due to temperature and from leakage, and that there is no practical loss from *condensation* as far as bulk is concerned. I happen to know that in the gas works at Birmingham a partial explanation of the very excellent leakage results is found in the fact that they do not have the heavy traffic that is the accompaniment of large gas works in large cities. They also have few street lamps, which are uncertain leakage factors; but at the same time that only in part lessens the credit of having gotten down to 2.7 per cent. of leakage, which I think certainly entitles one to credit. It is much further than a good many have gotten to on the leakage question. In moving a hearty vote of thanks to Mr. Nettleton for his paper, which has given us much to consider on an interesting question, I think we ought not to forget that one of the chief factors of small leakage at Birmingham, Conn., is Charles H. Nettleton. (Applause.)

MR. E. McMILLIN—One point which is of special interest to me is the one discussed by my friend Somerville—the large difference between the leakage at Birmingham and in other places; and I would suggest now that each man, in his own mind, try to reduce the yield per pound to Mr. Nettleton's standard—or his per cent. of leakage up to yours—and see if you differ a great deal. For instance, I have a works now in my mind that by their station meter show that they make about 5.17 feet per pound, and yet they have an average leakage of 11 per cent. Now you put his yield at 5.17 and his leakage will be about 11 per cent.; and if you put the other man's yield down to 4.77 his leakage will be about 2.7. Now we will all slip along in somewhere between those two points, and we do not differ very much.

MR. W. H. PEARSON—I would like to ask how Mr. Addicks

manages to isolate the various districts in the city of Boston, considering there are a number of gas stoves and a great many lights burning during the day time. I would like him to explain how he manages to accomplish that.

MR. W. R. ADDICKS—We go around and put them all out. It is very seldom we cannot get the amount of gas used in that way—I know there are cases where we have taken a Sunday test, but as a rule we get the gas shut off. The test department has 2000 valves.

MR. C. H. NETTLETON—Mr. Clark has called attention to the low cost per mile of stopping leaks in 1890—it being $14.57. Of course it is possible there may be an error in the figures, but so far as I know the accounts are kept reasonably accurate. I do a good deal of the work myself, and I try to charge up everything that properly belongs to the leakage account. But would it not be fairer to take the average cost of two or three years, and say that that average was the cost per mile for driving the 600 or 800 holes in question. I think everyone, whose mains are laid in soil such as we have, and who have not tried the method I have suggested, will be surprised at the low cost of driving the holes. It is really very slight indeed. In answer to Mr. Somerville, I can only say that I was surprised and pleased when at the end of the year I found that the leakage showed as small as it did. I had no idea of obtaining any such result; and, in explanation, all I can say is, first, that I believe that my meters are correct; and, second, that the pipes are tight, or nearly so. The men go along, not mile after mile, but thousand feet after thousand feet, and do not find a trace of gas. In regard to the yield of 4.77. It is somewhat low; and as I suggested in my paper I think if the yield had been larger the leakage would not have been so small. After all it comes down very much to the question of how much gas can be sold to the pound of coal carbonized; and when a manager can account for 4.60 or 4.70 feet of gas per pound of coal, it makes very little difference whether his leakage is 2 or 10 per cent.

MR. F. C. SHERMAN—I would like to ask Mr. Addicks where he found the leaks—around the joints or in the services principally?

Mr. W. R. Addicks—In both. There were very few broken mains, and nearly all the leaks were due to bad cement, or lead joints, or rusting at the services. I cannot give you the proportions found in the test department, but I can give you the proportions of all those that were found. There were 1,073 leaks found and stopped in six months, by the main department, consisting of 172 cement joints, 699 lead joints, 59 broken mains, 97 leaky services, 21 leaky lamp services, 10 leaky columns, 3 leaky gates, 9 pick holes, 2 drip pipes, and of the total number 713 were found by testing. That was the result of six months.

Mr. F. C. Sherman—The Company a few years ago used to confine themselves exclusively to cement joints. Were those cement joints and lead joints some that you put in, or did you find them there?

Mr. W. R. Addicks—They are a mixture. The Company now lays one lead joint to two cement joints. That is its rule. When it comes to good ground, where there is no liability of disturbance, we lay one lead joint to every 100 feet; but the number of broken mains is rather appalling there. I have known as many as two 12-inch mains broken in two days. You will notice that there were 59 breaks in those that I have given you. Of course they all occurred in the winter months. We do not have any broken mains in the summer time.

Mr. F. C. Sherman—I find that outside of New England it is largely the custom to use lead joints. In New England cement joints are almost universally used. I think it is better to have a broken pipe than to have every joint in your circuit leaking.

Mr. W. R. Addicks—I agree with you entirely, and I can cite the old Boston Gas Company in support of that statement. We tested what they laid seven years ago, part of it in fairly good ground and a part in made ground. In the made ground every lead joint leaked, and every cement joint was broken, on account of the settlement, as of course cement joints are not as strong as the cast iron pipe. I must confess that I do not believe in all lead joints, although I did believe in them a few

years ago; but in Boston I do not believe in having all lead joints.

Mr. F. C. Sherman—Do you continue the system of gates?

Mr. W. R. Addicks—Yes. In the first place, Boston proper is properly piped, and the additional number of gates is comparatively but a small item to continue; and we find it wonderfully convenient to keep up the system. We have no difficulty in shutting off gas anywhere in the city. I found as many as three gates in succession were rusted, half the way open or all the way open, and were of no value, but since they are looked after they are all in good condition and are kept so.

Mr. F. C. Sherman—That system of gates was adopted after the great fire. Have you had occasion to use those gates in case of fire?

Mr. W. R. Addicks—Yes; on the occasion of the Thanksgiving fire, three years ago, we had to shut all the gates on our 18-inch main and connections. That is the only way we got the fire cut off. We found the mains in front of buildings broken. They were very useful at that point. But I doubt very much, in laying out the Boston system, if they would now recommend spending the enormous amount of money necessary to put in the 2,000 gates.

The President—We have heard a very interesting paper, and have had a valuable discussion of the subject; and I have the pleasure of putting the motion of Mr. Shelton, tendering the thanks of the Association to Mr. Nettleton for his paper. [Adopted.]

The President then introduced Mr. Walton Clark (Philadelphia, Pa.,) who read the following paper on

METER RENTS—A QUESTION OF EQUITY AND POLICY.

The equity or policy of the common practice of selling gas to consumers of different volumes, at prices that bring to the seller different profits per 1,000 cubic feet sold, has met with little question. I propose to make some suggestions that have

come to my mind in this connection. Its relation to the title of this paper will appear later. Preliminary to my argument I assume certain propositions as generally admitted, viz.: (1), a gas company ordinarily has, and it is to the general interest that it should have, a regulated monopoly of the right to open streets and occupy the subsoil for the purposes of gas supply; (2), its rights have their origin in the citizens of the State; (3), these rights involve peculiar obligations to the public granting them; (4), in common with railroads, and other corporations performing a public service, a gas company is under obligations to make no distinction in its treatment of individuals served by it.

A corporation doing business as a gas manufacturer or common carrier is entitled to an interest on its investment in plant and working capital, the amount depending from complex considerations which I shall not attempt to analyze; for the limit, whether 5 or 50 per cent., is not material to my argument. Is it entitled to collect upon the investment necessary to the service of any one customer, an interest greater or less than is paid by any other customer upon the investment made in his behalf? Not if the fourth proposition as above is sound. Aside from mere business courtesy, the question of equal treatment can include only the financial question, the doing of a service proportionate to the payment received, and it is evident that the measure of the service is incomplete until consideration has been given to the amount of investment involved.

Obviously, a corporation is not rendering equal service for equal money, if it is collecting from one patron an interest charge to be applied on the investment in behalf of another patron. This principle of the obligation of corporations performing a public service to vary their charges only as the cost of the benefit charged for varies, has had expression in legal decisions. One of the clearest and most to the point, as indicating the duty of railroads in the direction in which they are unquestionably akin to gas and water companies, is by the eminent Judge Baxter, of the Sixth Federal Circuit. In a decision rendered in a suit against the Pennsylvania Railroad Company for damages resulting from a discrimination in charges on coal carriage based upon difference in quantity (all being in carload

lots), Judge Baxter, in deciding against the railroad company's right to make the discrimination charged and proven, says:

"A reference to recognized elementary principles will aid in a correct solution of the problem. The defendant is a common carrier by rail. Its road, though owned by the corporation, was nevertheless constructed for public uses, and it is in a qualified sense a public highway. Hence everybody constituting a part of the public for whose benefit it was authorized is entitled to an equal and impartial participation in the use of the facilities it is capable of affording. Freight carried over long distances may be carried at a reasonably less rate per mile than freight transported for shorter distances, *simply because it costs less to perform the service.* For the same reason passengers may be divided into different classes and the price regulated in accordance with the accommodations furnished to each, because it costs less to carry an emigrant, with the accommodation furnished to that class, than it does to carry the occupant of a palace car. It has been held that 20 separate parcels done up in one package, and consigned to the same person, may be carried at a less rate per parcel than 20 parcels of the same character consigned to as many different persons at the same destination; because it is supposed that it costs less to receive and deliver one package containing 20 parcels to one man, than it does to receive and deliver 20 different parcels to as many consignees."

The meaning of this and similar decisions, is plainly that corporations organized to do a public work must so regulate their charges that the net return to them, or the profit they make, shall not vary per unit of service rendered. It is their privilege—more, it is their duty—to collect, for a unit of product involving greater expenditure than another, a sum beyond the standard charge, representing the additional labor, interest, or other charges going to make up the additional expenditure. With railroads a nice adjustment of the labor item is a matter of some difficulty. The interest and maintenance and repairs items are little affected, except in the case of different classes of passenger business, but at the best only an approximation to the standard demanded by Judge Baxter can be attained. In the gas business, the problem offers little of difficulty. The at

once simple and equitable plan is to charge for each 1,000 cubic feet of gas an amount covering its proportion of the items of expense and interest common to the performance of the total service, adding to each bill so made the items peculiar to the individual service.

It needs no demonstration that the cost of gas in the holder, including interest and taxes on the investment at the works, and the salaries of officers (not clerks) will not be affected by the mere number of consumers. It is the volume made, not the number of people to whom sold, that will in any given locality determine these factors in the cost per 1,000 cubic feet sold It may be questioned whether the investment in distributing mains per 1,000 cubic feet sold, is not greater for the consumer of few thousands than for the consumer of many thousands. A gas company in laying out its mains in the city in which it does business, plans to put down its pipes wherever it sees the prospect of getting its legitimate return upon its investment. If it goes elsewhere, it is to make for itself that local popularity which shall tend to the greater security of its investment, and thence to a lower price to its consumers generally. If it makes an extension for an individual consumer to do business that will not pay its proportion of the interest on the general investment, such extension may legitimately be regarded as a service pipe and its cost treated accordingly. It might be claimed that a distant customer, while profitable, involved a greater expenditure to reach than a near customer, and that on this fact the latter might base a claim in equity to a lower price. If such an assertion had force it would carry with it the obligation on the part of the company to so locate its works that no consumer should be at this disadvantage as compared with another; an obvious impossibility. The duty of a company in this direction appears to be to locate its works on the most suitable spot and regard its mains as part of the investment for the general supply, maintenance and interest going into the charge for gas.

These considerations lead me to the belief that no injustice attends the assumption that, per 1,000 cubic feet sold, there is no difference in the cost of supplying the consumers of large or small volumes, up to the inlet of the service pipe. Thence, to the outlet of the meter, where the gas passes from the con-

trol of the company, the items of cost, viz., service pipe and meter maintenance, and interest, as also the cost of keeping one account, collecting one bill and attending to the complaints of one consumer, are not the same for each unit of volume of gas sold, are readily determinable, and, if our principle is true, are legitimately the subject of a separate charge against the consumer. It may be objected that office rent is an item as large for a consumer of few, as for a consumer of many thousands, and, therefore, if the principle under discussion were carried out, a proportion of it should enter into the fixed charge against the individual consumer. An office in a convenient part of the city supplied, must be rented or owned by the gas company whether the number of consumers is large or small. There is a proportionately small increase in the room necessary to the accounting force, with each increase in the number of consumers commensurate with the amount of work one bookkeeper can do. While this should in principle follow the charge for the bookkeeping, I believe it forms an item too small and difficult of determination to be considered.

It may be objected that the costs of attending to complaints, keeping gas accounts and collecting bills, do not vary in proportion to the number of consumers; because a bookkeeper, now keeping the accounts of say 1,500 consumers, could attend as well to 2,000, and a similar statement may be made of the employees concerned with complaints and collections.

It must be assumed that in any gas office the time of the employees is, practically, entirely occupied at one or another class of work, and that where there is more bookkeeping and collecting work than a given number of clerks can attend to, and less than that number plus one can do, the idle time of the one clerk is put to some good use. That this is so in any well regulated office cannot be doubted. There need be no idle time except that of complaint men waiting a call, a necessary part of their duty, and it seems fair to regard them, and the bookkeepers and collectors, as employed on each account just that proportion of their time that the total number of accounts one man can attend to when fully occupied bears to his full time. Where, as in the smaller offices, one man does several kinds of work, only part chargeable to the individual accounts, this part

is easily determinable. To repeat, there appears no difficulty in ascertaining for any works the amount of the charge to be made up of those items of cost which are not dependent on the volume of gas a customer buys, and which must be charged to him as a fixed sum per month (generally called by my title "Meter Rent"), if the principles laid down above are to be carried out. This charge would be to each consumer the same, only to the extent that it covered the items of bookkeeping, printing, collecting, etc. The items of service pipe and meter maintenance and interest would vary with the sizes of each and the length of the former. The details of the determination and recording of such charges offer no difficulties, as a moment's thought will convince anyone familiar with gas accounting. The approximation to absolute equity could be very close.

What would be the effect of the adoption of this principle in our business? First, on the consumer, what? The purchaser of the average volume of gas at average meter and service pipe costs, would not be affected, except in the form of his bill. He would be charged a "meter rent" covering the items above discussed, and a correspondingly smaller amount for his gas, the total being the same as under the present plan. The consumer of a volume less than the average would pay a somewhat larger bill per unit volume; the charge for gas being the same per volume, and the increase due to the fixed charges being divided by a smaller number of units. The consumer of from a few hundred feet down to "no gas" per month, would pay the cost of keeping up his meter and service pipe and collecting his bill, the items that now make his patronage unprofitable to the company supplying him, and any gas he used would then yield the same profit per unit of volume as the gas used by larger consumers. Thus would the man who insists on having a meter to insure against the failure of other sources of light, or to illuminate his house on festive occasions, become a source of profit to the advancement of justice and the interests of the company and its patrons. The consumer of more than the average volume of gas, under average meter and service pipe cost conditions would get his gas at a cost less per unit volume than that of smaller consumers, by the amount that it cost less to supply him. Large consumers who are now enjoying rates lower than

the average by a sum in excess of the difference in cost of supplying them, would find the price higher to them than under present conditions. Inasmuch as concessions in price to large consumers are generally asserted to be based on the justice of giving them the advantage of this difference, advocates of such concessions must hail the plan under discussion as contemplating a complete and systematic enforcement of their principles.

It must be noted that these disproportionate concessions to large consumers are claimed, with some show of reason, to be not to the disadvantage of the smaller consumer, because the measure of profit obtained on the gas sold them goes toward the payment of the dividend on the investment already made, and this, it is asserted, reduces the amount of profit to be obtained from other sales. Two answers to this argument are obvious. It cannot be certainly predicted of consumers of this class that, unless they obtain unreasonable concessions, they will not burn gas; and, inasmuch as the investment must ultimately be increased in proportion to the demand for gas, the accession of this class will not affect the interest account. Hence, to obtain them at largely reduced rates may have an effect on the price to the smaller consumers the reverse of beneficial The supporters of this argument in favor of special prices to large consumers are misled by the generally existing margin of capacity in a plant, into the feeling that no new investment is necessary to supply the new customer. Each new customer narrows the margin, and advances the day when more investment must be made, and should, therefore, be regarded as requiring an investment in plant, exactly proportioned to the amount of his consumption.

The effect of the adoption of the principle in question on the gas company—What? The conditions under which gas companies do business in their relation to the principle under discussion, vary, and certainly the immediate effect of the enforcement of this principle would be as various. Custom breeds a sense of obligation, and doubtless many consumers at lower than regular rates have come to accept the reduction as a vested right, and would threaten and probably at first, make trouble, if their price were raised. The abrupt adoption of this principle by a company already established in business could be ac-

complished with the minimum of friction only at the time of making a reduction in the price of gas; small consumers being then put on the same footing as large, in the price per unit volume, the price to the large consumer not being raised, and the meter rent charges giving him all the advantage in total cost that he is entitled to. Doubtless many large consumers would claim that a lower price than this arrangement would give should be granted them, and threaten us with electricity; but in the light of our present knowledge of the cost of incandescent electric light, does it not seem that we are making undue concessions to large consumers from fear of it? Every concession so made postpones the day when we may again advance upon the other and more formidable enemy to the extension of our business. Kerosene is the competitor that can block us out of one portion of the trade we seek, and always to its own profit. When the incandescent electric lamp displaces us by reason of a lower price, it is seldom to its profit, and such a warfare cannot long be maintained. Therefore, it appears that in the long run the large consumers who now make us afraid with their threats and acts of wiring their buildings if they do not get a reduced rate, will again work the meters that they at all times refuse to have disconnected. In seeking indications of the ultimate effect of a new departure, the effect, after the influences of the old system had passed away, no method is safer, nor more simple, than to study the probable course of an enterprise started on the new lines, unembarrassed by precedent. Where would a gas company stand to-day, financially, and in the graces of its customers, if it had adopted at and adhered to from the beginning of its existence, this principle of placing all consumers upon the same plane? The justice of such a course must commend itself to all men. The fact of meter rent charges being an old story, and the reason and effect of them understood, would probably prevent any general objection to them.

Equitable treatment is a long step toward popularity. The prevalent idea of a meter rent has been that it represents what the Creoles call a "lagniappe"—something demanded in addition to the regular and legitimate payment for service. Once understood as a fixed charge made to put all consumers upon

the same footing, and that it is not an addition to the cost of gas, objections to it would be few, except on the part of people who, from the smallness of their consumption, are now a burden on the company and its other customers. Hence it would appear (always supposing my reasoning to have been good) that the adoption of the principle of meter rents and uniform prices per 1,000 cubic feet would not result in a smaller measure of popular approval than gas companies now enjoy.

The active competitors of gas for the business it would call its own are kerosene and the incandescent electric lamp; the former in residences and stores, the latter in stores, factories, etc. The only desirable class who would be prejudicially affected by an abrupt change from the old system of charging to that under discussion, the consumers who now get special rates, make their choice between the incandescent electric lamp and gas. If the former is cheaper to them it is unprofitable to the company supplying them, and this competitor need not be greatly feared where the issue is made on the mere dollar and cent grounds. The objection that isolated electric plants will be put in by large consumers, if they are not given special gas rates, is answered by the fact that this is done to the greatest extent where gas is cheapest, light for light, in the large cities. Where the incandescent electric lamp is used to-day, and still more, where it will be used five years from to-day, unless some means of cheapening it can be found, the deciding argument between it and gas is not, nor will be, the financial. But if it were, the greatest inroads upon our business made by this competitor at this date appear to be among the class of customers (stores, saloons, etc.) who buy from us more gas than the average, and less than the special rate customers; the class that would be most benefited by the adoption of the "meter rent" system in the meaning of my title.

These considerations lead me to believe that the adoption of the equitable plan of selling gas to consumers of large and small quantities at prices that shall result in the same profit per 1,000 cubic feet to the company supplying it, would not prove injurious to the company's interest.

An editorial on a subject akin to mine and discussing the claims of large consumers to be considered wholesale purchasers

and therefore given a low rate, appeared in the issue of *Progressive Age*, of May 15, 1890. It will pay the manager, to whom this question is of interest, to study it.

Discussion.

THE PRESIDENT—You have heard a very carefully prepared and terse statement, by Mr. Walton Clark, upon this very important question, and I trust the members will give it ample and free discussion. It is as old a friend of ours as "leakage," and nearly as dear to our hearts as "naphthaline." As the question of meter rents is a burning one to many of us, I hope many of you are prepared to discuss it; and I know that Mr. Clark is ready to answer any questions.

MR. A. G. GLASGOW—The Chairman is correct in the statement that the question of meter rents is an old one. I do not think, however, that that view of the case exactly expresses the idea conveyed by Mr. Clark's paper. As I understand it, what Mr. Clark proposes is a solution by means of meter rents of the vexed question, "What reduction is it right to allow to the large consumer of gas from the standard price to the average or small consumer?" I followed Mr. Clark's reading of the paper as closely as possible, but I find it hard to criticise this question favorably without rehearsing to a very considerable extent what Mr. Clark has already stated; and to me it is equally difficult to discuss or criticise the paper unfavorably, because I find nothing unfavorable to say about the proposition. The keynote to it seems to me to lie in the question, "Is it fair, just or lawful" (I perhaps almost quote Mr. Clark's words in this respect) "to charge one consumer of gas a greater interest on the investment necessary to serve him than we should charge another consumer on the investment necessary in his behalf; each one, by Mr. Clark's system, paying his exact proportion of the general expense of distribution?" I doubt if there be a person here who would have answered this question affirmatively, whose opinion has not been severely shaken by hearing this paper; and I am pretty well satisfied that the careful reading of it will entirely revolutionize his opinion. Following up the judicial discussion quoted by Mr. Clark, what are our rela-

tions to the public? People aggregate to form cities; they combine for their mutual convenience; they construct lines for rapid transit, or they give franchises to others to construct and operate them in their behalf; they form police systems; they have the streets paved; they establish fire departments and build water works. They require light. In many cases they serve themselves, and in the other cases they employ corporations to furnish light for them, authorizing them to use the thoroughfares, that are owned in common by all. It would seem to me as just to charge different citizens such prices as will give us varying profits per thousand, or per unit of our product—as just to do that as it would be for the city to levy upon the people varying rates of taxes in support of the above named institutions. We supply light for the same purpose for which they pay taxes—for the general convenience of the citizens. I feel that I have not in this connection said anything that strengthens Mr. Clark's position, but I did not expect to do that. I simply wished to put myself on record as indorsing his position in this regard. Of course, it goes without saying that if a body of gas men are convinced that a certain step is morally right, nothing else will enter into their computation.

Looking at it, however, as a matter of policy, as some of our friends in the electric light business, and in the water business, or something of that sort, might do, it seems to me that on this ground also Mr. Clark is entirely right; and that it is for the benefit of the gas company not to sell their product to a man, because he is a large consumer, at a rate which does not give them the stipulated return per thousand. We sell to the average consumer at a price which gives us a fair return on our product. Where is the point in selling to anyone at a price which does not give us such a return? The thought that first occurs to many of us in this connection is that we have a plant capable of putting out a certain amount of gas, and it is working only to, say, two-thirds of its capacity, while those who are burning that two-thirds capacity are already paying enough money to make the usual rate of interest on the whole investment; and it seems to be reasonable at first thought that we can afford to fill up the plant at a lower rate per thousand. As we are already getting interest on the investment, why cannot we sup-

ply the other one-third simply at cost? Or, suppose we say that we will make a little on the other one-third; that we will sell the other third at a reduced profit, which, added to our present earnings, will make us that much better off. Apart from the injustice of making two-thirds of our customers help bear the burden of the other third, what is the immediate effect of such an arrangement? We fill up our plant; another consumer applies; then, according to this reasoning, that one man must be charged with all the money that is necessary to invest in a new works or the enlargement of the present works. That is the necessary result of this line of reasoning when carried to its limit. If you fill up your remaining one-third at a less rate than is necessary to pay its fair proportion of interest on the invested capital, then, your margin of capacity being exhausted, this one man, the last straw that breaks the camel's back, must contract with you to pay for the new gas works, or you cannot afford to let him in. The more I have looked into the matter (I do not pretend to have looked very far, but I have looked as far as I can see) of supplying small consumers, the more I am satisfied that every gas company has a large number of small consumers to whom they are monthly handing out so much money for the pleasure of allowing them to keep a meter and burn, occasionally, a small amount of gas.

A great many works have adopted the plan of sending out a bill for a certain amount whether they burn it or not. That is one way of getting around it, but it is an arbitrary way. This plan under discussion seems to me to be practicable, and, as it is based upon figures, it is certainly just. By its adoption the gas company will receive per 1,000 feet of gas consumed the same amount of profit from the consumer, whether he be a big or little consumer. If he be a big consumer he is delivered the gas cheaply, and to that extent he gets the benefit of it. He gets the benefit of what we are able to save. Outside of that I do not see but what the small consumer has to suffer for whatever concession we give him. The small consumer is a very valuable man—if he is not too small; and Mr. Clark's system protects us against the man who is ordinarily too small by a method that enables us to make money on him.

Mr. E. H. Jenkins—I understand Mr. Clark takes the position that gas companies and railroads, as public servants, should work upon nearly the same principle. We who come from very small towns, and get into New York city only occasionally, and have occasion to use the "L" road and the horse-cars, find that on the "L" road you can ride ten blocks and pay a nickel, or you can ride 120 blocks and pay just a nickel. Would it be policy for that road to undertake to charge different prices for the different services rendered?

Mr. Walton Clark—I would like to say in answer to that suggestion that if the same rule were applied to the "L" road that is applied to the longer roads they would be compelled, as far as they practically could, to make that distinction; but there is so little difference of cost in the general business of the "L" road, between carrying a passenger ten squares and carrying him 120 squares, that it is not worth considering. It is not worth the trouble or expense of keeping track of where a man travels to on the "L" road. If they attempted to do that it would in the end cost the traveler more who only traveled ten blocks than it costs him now to travel 120 blocks—if they put on the laborers, ticket men and gate men whom it would be necessary to have to keep track of where a man is going. Otherwise it would be done, because there is no uncertain language in the decisions relating to railroad management; and the Interstate Commerce Law or the discussion preliminary to it covers that point perfectly.

Mr. E. H. Jenkins—I recognize very clearly the fact stated by Mr. Clark, that it is not practicable to make that distinction; but would not the difference between supplying one customer and supplying his next door neighbor, be so very small that it would be impracticable for us to carry out your plan? Don't you think they would get mixed pretty nearly as badly as the "L" road passengers would be?

Mr. Walton Clark—If the customers, side by side or ten miles apart, had meters of the same size, and services of the same length, and used the same amount of gas, it would cost exactly the same to supply them; but if one consumer is a church, and uses 3,000 feet of gas per month, and has a 100-

light meter through which to measure it, and a corresponding service, while the consumer next door is a householder, and uses 3,000 feet of gas per month through a three-light meter, and has the service necessary to supply him that amount, then to supply gas to the church costs several, say, about ten cents per thousand more than it is costing to supply the consumer through the small meter. There is a very decided difference, and it is a difference that is easily gotten at. There is no difficulty about it. It does not add to the clerical force of the office at all. A table giving the cost of placing and maintaining different sizes of services and meters is all that is necessary; the charges are worked out from that, and the thing is done. If you will give a little thought to it you will see that that is very simply done.

MR. E. H. JENKINS—I acknowledge I have not given much thought to it. The paper is new to me, but those questions flashed on my mind very quickly. I think in the case you speak of, as between the householder and the church, there would be quite a little difference, and that 10 cents per 1,000 would be a pretty high figure. But between the consumer with a 5-light meter, and who uses 5,000 feet per month, and the consumer with the same size of meter, who uses 7,000 feet per month, I think there would be very little difference.

MR. T. LITTLEHALES—If I understand Mr. Clark's position, the conclusion he arrived at is that the only equitable method is to charge meter rents. Is that the point?

MR. WALTON CLARK—To charge a something, which I have called "meter rents," and which covers interest on the cost of meter and service in use at the place, the cost of repairing that meter and service, interest on the cost of repairs, and the cost of collecting the bill—all of which is so readily determined that, sitting at my desk, I worked the whole thing up for two different sized meters in 60 minutes.

MR. T. LITTLEHALES—So your conclusion is that charging meter rents is the more equitable system. With that conclusion I entirely agree.

MR. WALTON CLARK—Charging a meter rent covering all those points. It is really more than a meter rent.

On motion of Mr. Jenkins the thanks of the Association were voted to Mr. Clark for his paper.

The President then introduced Dr. A. W. Wilkinson, of New York city, who read the following paper on

LIME.

Mr. President, Gentlemen of the American Gas Light Association, I do not think your committee fully appreciate the difficulties that one would be subjected to in writing a paper to be read before your meeting.

I see before me men who have spent years in the manufacture of gas, and are perfectly familiar with everything connected with it; men who have read every book published upon the subject; men whose written articles are to-day the law in every country on the subject of gas making.

A paper should be not only interesting but instructive, and, if possible, contain something new. How can I instruct you gentlemen; what is there new to present? Nothing. I am forced to take up a subject that has been written on many times, and I do it in its defence. I refer to lime. Lime is so universally distributed in this world that, turn whichever way we may, we are sure to see it. Take up a handful of earth, what is it? A mass of oxidized metals, and lime is sure to be one of them; go deeper, examine the rocks, lime is sure to form a part. We can hardly find a stone or rock that does not contain lime.

If we analyze the waters of the earth we will surely find this all-important substance, lime; even the air contains lime.

Leaving this earth, and by the aid of the spectroscope examine the light given by the sun and the fixed stars, we see the beautiful red, yellow and green bands which tell us that lime is burning there.

To Sir Humphrey Davy we are indebted for demonstrating that all earths have for a base a metal. In 1808 he isolated calcium from a lime compound—28 pounds of caustic lime contains 20 pounds of this metal. Of the 54 metals known on

this earth, most are white or nearly so; the others have the color of gold (with which you as gas engineers are so familiar). Unlike gold, calcium is very oxidizable.

I have here a sample of calcium; it has to be kept in naphtha, a substance free of oxygen, to prevent it turning to the oxide of calcium, or caustic lime.

I do not propose to speak of the thousand and one salts of lime, although they form an interesting and useful class of bodies, or of the many rocks that lime forms a part, but will confine myself to the great group of carbonates.

We find the carbonate of lime precipitated from the waters of the earth and often mixed with other earths known as lime rock; in the latter rock formation again, as marble, which at one time was some form of shell life, having been subjected to both heat and pressure. Occasionally, instead of the pure white marble, we find it black, or yellow, or green, or flesh color, in fact, every shade of the rainbow, depending upon a slight amount of coloring matter, but in all cases being almost pure carbonate of lime. Again, the shells that we see upon the seashore, or the coral that forms so much of our earth in the equatorial regions, are carbonate of lime; the beautiful pearl that we admire so much, and at one time when dissolved in vinegar formed an expensive and fashionable drink, is carbonate of lime—I doubt if a cocktail made of pearls would meet with ready sale at the present time, although, as a medical preparation, it might be very useful.

I have here a crystal of carbonate of lime, Iceland spar, which possesses the wonderful power of polarizing the ray of light; that is, enabling one to see double without the aid of diffusible stimuli. May it not be possible that some engineers have glasses made of this substance when they report the amount of gas made from a pound of coal? Gas consumers swear that the clerks who make out their bills, wear glasses made of this substance continually. Heat the crystal, drive off a little water and carbonic acid, and you have left, caustic lime. When any of the forms of carbonate of lime are subjected to heat in a draft of air, or better still, both air and steam, the carbonic acid is driven off and we have left, caustic lime. This substance has a great affinity for water and will combine with it so actively

that a great amount of latent heat is set free—the compound formed is the hydrate of lime, the substance that you gas engineer are so familiar with, and spoken of as lime.

The burning of lime is carried on for so many purposes that it scarcely needs more that a passing notice; yet to do it properly we require something more than the heaping together of a quantity of lime rock and fuel, setting the fuel on fire and allowing it to burn for a number of hours. Many patents have been taken out for lime kilns, claiming great economy in fuel and producing pure caustic lime, the secret of success being a free draft of air aided by a little steam. It was customary at one time for gas companies to do their own lime burning, and I am sure to-day that it would be one of the best paying and most useful department of the works.

Soon after the discovery of gas making by Murdock, lime was suggested as the best substance for its purification, or to free it from its bad smell.

It was known that whitewash in some way purified the air of the room in which it was used, but the chemistry was unknown. The fact that lime would thus act led to its use as a purifier of gas, first, in a liquid form, or cream of lime. Some possibly remember seeing in our old works boxes arranged for passing the gas through the lime. In this shape it did its work very effectually, in fact too well; for often much of the illuminants would be washed out. The fact that the lime becomes very offensive in removal led to its discontinuance, and the substituting of lime in a comparatively dry state, such as we are familiar with in all of our works to-day.

Many substitutes for lime have been offered for purifying gas and they have all failed to meet all of the requirements in effective work, or come within the limit of cost. The only one that has at all become popular is the hydrated oxide of iron, and this only in part fulfills its mission. Lime will filter the gas, absorb the sulphureted hydrogen and carbonic acid. With iron we can only do the first two, allowing the carbonic acid to go free, to the great injury of the quality of the gas, causing it to burn with a reddish light, with tendency to smoke, for carbonic acid is a regular dog in the manger; it will not burn itself or let the other combustible gases burn. Many engineers who

use iron for purification make up the loss of light by a little more of the enricher, be it either cannel coal or oil; but this method is never quite satisfactory, the oxide's recommendation being its cheapness and the enormous amount of gas it will purify. The place for the iron is before the lime; that is, pass the gas through the iron box, then through the lime.

At the present time there is a great competition in light, and it obliges the engineer to not only give a volume of light, but it must be of a fine quality, and the lime, the good, old and faithful servant that has been with us since the beginning, can do more to secure that than any one thing; help it if you choose with iron, but do not try to do without the lime.

It has been asked, how much gas ought a bushel of lime to purify? Twenty-eight pounds of pure caustic lime, when properly slaked, that is, converted into a hydrate, will combine with 22 pounds of carbonic acid, or 188 feet. The same weight of lime will combine with 17 pounds of sulphureted hydrogen, or 188 feet, but these figures are of no practical use, for the reason we never have pure lime rock, or shells, or marble, and often it is imperfectly burned, or is imperfectly slacked, or it has been exposed to the air and already absorbed carbonic acid, and possibly sulphureted hydrogen—the boxes may not be of the best form, or the lime properly put in, and then again, we have the gas with a greater or less percentage of impurities. So you see, to give the exact amount that a bushel of lime will purify, you require to know all of these facts.

Some engineers think that lime should purify the same amount of gas, no matter what the condition of the gas is. For instance, coal will be purchased that contains 5 per cent of sulphur, which, when subjected to distillation, is sure to give sulphureted hydrogen, bi-sulphide of carbon, sulphide of ammonium, in large quantities. Again, the coal will be used wet, or often covered with snow and ice; such coals will make large quantities of carbonic acid, and the amount of lime for purification will be proportionately increased.

With your permission I will suggest what would be an ideal plant for coal gas making, that would give the lime the best chance for effective work:

1st. A bench so well set that the retorts shall be uniformly

heated, whether by an ordinary or a regenerative fire, to a high heat.

2d. That the coal should be a good coking coal, free as possible from sulphur, and dry; that is, it should be kept well housed, for coal exposed to the elements rapidly deteriorates.

3d. As high heats should be carried as can be carried without producing pitch in the hydraulic main.

4th. The exhauster should be run so as to keep as near zero in retorts as possible—to produce a vacuum in the retorts you run the risk of drawing in furnace gases, and a pressure means less yield.

5th. The condenser should be ample so as to cool the gas gradually. In a small condenser the gas rushes through so rapidly that much tarry vapor or oily compounds escape condensation, going over to foul the pipes and other apparatus and coat the lime, preventing it from absorbing or combining with the carbonic acid or sulphureted hydrogen.

6th. Condensers are almost always too small. Perhaps they were large enough when first constructed, but the growth of business soon overworked them and no provision is made for extension.

7th. Next, the scrubbers—here a most important part of the purification takes place. Experience has taught that to wash with pure water is an injury to the illuminating power; to pump the water over and over again until it is saturated with the chemical compounds, is less expensive and produces better results. One cubic foot of water will dissolve 480 cubic feet of ammonia, the carbonate of ammonia which is formed by bringing the ammonia and carbonic acid together is also dissolved as well as the sulphide of ammonium, all of which is very desirable to remove from the gas.

8th. We now have the gas in such a shape that the iron, the use of which I should most surely advocate, will combine with the sulphureted hydrogen freely, one box being sufficient to do the work for many thousand feet daily. Finishing with the lime, which having only the carbonic acid to take care of, will do enormous work, surprising many who have been in the habit of neglecting the points I have mentioned before.

Coal gas made and purified in this way, is as pure and white

as can be desired; but it is limited in its candle power—16 to 18 is as much as you ought to expect. It is better for heating and cooking, or power, containing as it does, more heat units than any other gas. If you want more candle power (instead of loading it up with naptha vapor which will give you the increased candle power and at the same time change the quality of the light, making it reddish, and with great tendency to smoke) go directly to water gas. Here it is easy to get a 30 candle gas pure and white; if this is too high, a mixture of the two in equal parts is most satisfactory.

As I have followed the making of coal gas from the retort to its final purification, it may be well to do the same with water gas as you will see it made in New York.

The first step in the operation is to produce the non-illuminating water gas; that is, the gases made by the decomposition of steam by red hot carbon. For this purpose we require a cupola; that is, an iron vessel of from 6 to 8 feet in diameter, 12 to 15 feet high lined with fire brick. Into this we place coal and set it on fire, with a suitable blast. We bring the coal to a full white heat, then shut off the air and close the outlet of the products of combustion, open the valves leading to the hydraulic main; now turn on steam, which will be rapidly decomposed into carbonic oxide and hydrogen. These gases are forced into a holder, from the holder they pass to the illuminator, a vessel so arranged that the gases become thoroughly mixed with the vapor of naptha in such quantities as will produce the candle power desired. From the illuminator the gases and vapor of naptha pass to the through retort heated with oil or coal; it enters at one end and is converted in its passage through to a perfect gas. That is, the naptha will, in the presence of water gas, be entirely decomposed into illuminating gas, without waste oil or lamp-black. The exhauster sends it through the condensers and the same care should be observed as in coal gas condensing. You do not really need a scrubber, for we have no ammonia, very little sulphureted hydrogen to dissolve (a dry scrubber that will cause friction of the gas is well, but not a necessity). It is now ready for the iron and lime boxes. Four and one-half ($4\frac{1}{2}$) gallons of naptha will give a 30 candle gas.

At the Mutual works, this city, we have for years been re-

burning the spent lime. It is first pounded into bricks and then burned into caustic lime in kilns, the same as is used for burning brick. The cost for a bushel of slaked lime is from 3 to 4 cents.

There seems to be no limit to the number of times the lime can be reburned. It will purify just as much gas as when first burned. This places lime in the hands of engineers at a price that enables them to use it constantly, and make a gas that will not only compete with electricity, but will be vastly superior in brilliancy and cheapness.

Whenever you hear that electricity is making rapid strides in a place, you may be sure that the gas is poor or badly purified. We have a grand future for gas of high grade. The day for poor gas has passed, and the engineer who is content to make a gas that will burn, no matter how, red, yellow or smoky, will find his occupation gone. There is no excuse for poor gas at the present time. Material of the best is at hand. The science of gas making is well known. The public demands good and pure gas, and that can only be produced by the proper purification with lime.

Discussion.

THE PRESIDENT—In writing this paper, Dr. Wilkinson has added one more chapter to the large amount of instruction that he has given the gas fraternity. The Doctor will answer any questions that any of you may wish to propound with regard to the lime process.

MR. A. S. MILLER—The Doctor made one statement which I do not think anybody will dispute—in speaking of the milk of lime absorbing the illuminants of gas. Now, if the milk of lime will absorb the illuminants, will not dry lime do it? A test was made by Connelly & Co., about three years ago, of oxide against lime. The apparatus was very carefully arranged, and I think the gas contained about 2 per cent. of carbonic acid. That is my recollection from reading the article some time ago, and I am not sure that I am exactly right. However, this gas contained at least 2 per cent. of carbonic acid. The tests, after being very carefully made, show that the lime absorbs sufficient

illuminants from the gas to keep it down to about the same candle power as gas purified with oxide, but still containing the carbonic acid. I would like to say that in making gas now we are using practically only oxide to purify with—all the other conditions being the same as they were a year ago when we used lime entirely—and we are getting just the same results in illuminating power per gallon of oil used as we were a year ago. I think that the lime absorbs sufficient illuminants from the gas to keep the candle power down to the point that oxide will keep it, on account of not absorbing the carbonic acid.

DR. A. W. WILKINSON—In answer to that I would say the hydrate of lime has no effect upon the illuminating gases. Water will absorb 6 per cent. of illuminating gas—that is, 1 cubic foot of water will absorb 6 cubic feet of illuminating gas. Now, if you add your lime wet, it is not the lime that absorbs the illuminants; it is the water. If you have your lime dry (that is, a hydrate, for that is the sort of lime you have used) it will have no affinity for the illuminating gases; it can only combine with sulphureted hydrogen and carbonic acid. There is no affinity for the illuminating gases, and it cannot combine. The only possible deterioration that could take place would be as to what it could mechanically hold, but there would be no combination.

MR. WALTON CLARK—Lime as commonly prepared for the purifiers is not a simple hydrate; it certainly carries a large amount of water with it. I have been brought up to believe, and experience has borne me out in the belief, that the more water you could make your lime carry, and still leave it porous, the better would be the purifying effect, while at the same time a greater amount of hydrocarbon would be absorbed. So far from the hydrate of lime having little or no effect on the illuminants of coal gas, it appears from experiments to have very considerable effect. Mr. Blodgett described before this Association, at the last New York meeting, some very satisfactory experiments in that line, and I think he demonstrated completely that there was a greater loss of illuminating power from the use of lime than from the use of oxide. Perhaps I should not say "loss of illuminating power," but that there was greater

illuminating power in the same gas, or different portions of the same gas, passed through oxide than in that passed through lime. There is a gentleman here who told me (but as he did not say it before the Association I will not use his name) that he had thrown lime into the retort and made good illuminating gas with it after it had been used in the purifiers. In my own experience I have found that the oxide purified gas had as high illuminating power as lime purified gas, and that while the oxide leaves in carbonic acid, it also leaves in something else which the water in the lime takes out.

Mr. S. F. Hayward—I would like to ask Dr. Wilkinson what they use at the Mutual works with which he is connected?

Dr. A. W. Wilkinson—We first purify the water gas as it comes from the cupolas, and then it is passed through to the holder. After the oil has been added it passes through the boxes—the lower layer containing ashes, and the upper layer containing oxide of iron. Now, as regards the water that we have in excess over the hydrate in lime, I may say any excess of water of that kind is unnecessary, and should not be used. If you have ever used oxide of iron you will know that it always contains more or less water—possibly as much water as the excess of water in the hydrate of lime.

Mr. T. Littlehales—In the majority of works, where there are only four purifiers, and where they are using lime exclusively, I suppose the lime would come out in the shape of sulphide, or "blue billy." In that case, in burning the lime, would there not be a nuisance created by its reburning, in giving off sulphur in the form of sulphureted hydrogen? Have you experienced any difficulty in that direction?

Dr. A. W. Wilkinson—Not at all. I would say that the sulphur as soon as it is subjected to heat undergoes oxidation, and burns, not into sulphureted hydrogen, but into sulphurous acid, and passes off.

Mr. T. Littlehales—That is still worse.

Dr. A. W. Wilkinson—No; because you never burn a ton of coal that you do not produce sulphurous acid. It is simply the small amount of sulphur turned into sulphurous acid. With

us the amount of sulphur in the gas is very small; it is nothing like what it would be in coal gas making where a large percentage of sulphur exists in the coal. Hence we experience no difficulty whatever. Neither does the lime burn into sulphate of lime—plaster of Paris. This is well proved by analysis. After three or four hundred times reburning the lime we find that it purifies just the same number of feet per bushel as it did when first put in.

MR. W. R. ADDICKS—As I understand it, the more water there is in the lime the more illuminants would be taken out of the gases. If that is so, then the wet purification process (the milk of lime process) is better adapted for coal gas than for water gas. Does not that follow?

DR. A. W. WILKINSON—I do not see that. You are limited to the amount of illuminants in your coal gas. We will suppose that it is 6 per cent. by absorption. Now, you pass it through cream of lime and you can reduce that to 3 per cent.; consequently, you reduce the illuminants in that same proportion.

MR. T. LITTLEHALES—I think Dr. Wilkinson has overlooked one important fact with reference to the existence of water in the lime. I think every member of this Association remembers the light thrown on the purification question by the late Mr. Forstall, who showed us the enormous advantage to be gained by having the lime thoroughly wet. Now we must not forget that water, as ordinarily used, is itself a purifying agent, absorbing, as I have always understood, 700 times its bulk of ammonia gas, instead of 480, as you put it; that the water absorbs a large percentage of ammonia, and that the ammonia in turn neutralizes a considerable amount of sulphureted hydrogen. And so water that is held in mechanical combination with lime becomes a purifying agent. I still hold to the principle of having the lime pretty thoroughly wet, and I think that it is a more efficient purifying agent in that condition—due to the excess of water there is in it. Of course, if you have an ample wet surface in your scrubbers or washers, then it is not necessary.

MR. F. BREDEL—I want to state as far as the purification by lime is concerned, that lime has, under no condition, an affinity

for absorbing any illuminants whatever, provided such illuminants are in the form of gas, and not as vapors. But if they are vapors, naturally they make the lime easier of absorption, and the benzole vapors, or whatever vapor it may be, will be decomposed. If you keep the lime thoroughly dry they will not be deposited so easily. I think that explains why in the wet lime purifying process you absorb the illuminants. I think these illuminants would be lost somewhere in the holder, or somewhere in the pipes, so that there is practically no absolute loss from purification.

Mr. G. B. Neal—I understood Dr. Wilkinson to state there was a loss of 6 per cent. of the illuminating power of the gas by absorption, where water was used, and that it was not necessary to use water in the scrubbers in either water gas or in coal gas. Then I made up my mind that when I got home I would order the superintendent to shut off the water. That might do very well with water gas, but it occurred to me that there was a good deal of ammonia in the coal gas. Suppose we discontinue the use of water with coal gas, what shall we do with the ammonia? How shall we eliminate that?

Dr. A. W. Wilkinson—You misunderstood me. I should have said that in the scrubber we do not use pure water, but do use water that has been partially saturated with ammoniacal salts. As every gas engineer fully knows, it is far better, for the illuminating power, to wash the gas with ammoniacal liquors than to wash it with water. You will understand what I am driving at. I want to make the coal gas pure and white; I want to make it so that it will compete with electricity. I do not want that coal gas loaded with vapors of naptha, or with carbon gases; for that will make it reddish or yellowish, or so that it will have a tendency to smoke. Hence we make every effort to relieve the gas of every impurity, leaving the gas as it comes from the coal—good coal—well purified and of a beautiful white color. If you leave the carbonic acid in you have a reddish gas, with a tendency to smoke; if you load it with naphtha vapor you have a reddish glow. You increase the candle power, but the quality is deteriorated.

Mr. G. B. Neal—On one point you say you want to make

coal gas to compete successfully with electricity. As many of my friends are engaged in the manufacture of both kinds of light, we can offset one another.

MR. C. F. PRICHARD—Some years ago I was investigating the point whether lime absorbed any illuminants. We measured a sample of gas, filled a small holder with it, and made several complete analyses of it, with particular reference to the quantity of illuminants contained. We then passed a portion of this gas through lime. The result, in amount of illuminants, was substantially the same as it was before it passed through lime. We then repeated the same operation through iron sponge, and obtained substantially the same result—12 or 15 tests which we made showed there was no appreciable reduction in the amount of illuminants, either by passing through lime or through oxide of iron.

MR. A. G. GLASGOW—I have listened with pleasure and interest to Dr. Wilkinson's remarks about the reburning of lime, and I would like to ask him if he can recommend the reburning of lime as being commercially successful where the cost of disposing of the spent product is practically nil. I ask that question because I have recently looked over a very large plant where they burned the spent lime, and was told that it was not worked with commercial success.

DR. A. W. WILKINSON—I think we have now, for about six years, reburned our lime. The lime was originally shell lime. It had been used in the boxes until it ceased to be of value. We placed that lime in kilns, and subjected it to heat for about 16 hours. At the end of that time we found the lime had been converted into caustic lime. Then we placed it in slaking boxes, and it slaked into hydrate of lime. We find that it will do just as much work on the one-hundredth burning as it did at the beginning. The lime seems to be like sponge; if you put one in water it becomes full of water, and if you remove it and squeeze it the water will go out, after which it will take up just as much water again. The expense of reburning that lime has been, including every detail, from 3 to 4 cents per bushel. In the summer months it would be 4 cents per bushel, for that is when we have to repair the kilns. Now, gentlemen, think for

a moment what is that lime. It is the carbonate of lime. What do we do with it? We place it in the kiln, burn it, and thus drive off the carbonic acid. Slake it, and we have the hydrate of lime. Now, what have I coming from the lime boxes? Nine-tenths of it is carbonate of lime. Then I pound it into a brick, or into some other shape. When it is subjected to heat it undergoes the same process that lime does. I am doing nothing different from what was done originally.

MR. A. E. BOARDMAN—It seems to me that Mr. Glasgow's question resolves itself into the first cost of lime. If it cost more than 4 cents per bushel, then the Doctor's process is a saving; if it costs less, it is not.

MR. F. C. SHERMAN—I would like to ask Mr. Slater for his experience in the use of lime burned over. He tried it years ago, and I would like to have him tell us what he did with it.

MR. A. B. SLATER—We did have an experience with reburning lime—we used what is known as the Hislop apparatus, and found we could not reburn the lime with that apparatus to advantage. In other words, if our lime cost us 11 cents per bushel we could not burn it to advantage. We tried it for about a year. We found that where the lime contained carbonic acid we could reburn it several times, but that where it contained sulphur we could not reburn it to advantage more than two or three times, and we gave up the process of reburning it.

DR. A. W. WILKINSON—Was the lime in a loose, powdered state?

MR. A. B. SLATER—It was.

DR. A. W. WILKINSON—The secret of reburning lime successfully is that there shall be a free draft of air. It is better to have a draft of air and steam. Now, with loose lime you cannot do that. If it is pounded into a brick or is in lumps, so that there can be a free draft of air, aided by a little steam, the sulphur and carbonic acid both, will be driven out.

MR. J. F. SCRIVER—Mr. Baxter, of Halifax, has had some experience in re-burning lime, and I will ask him to state it.

MR. R. BAXTER—The conditions in Halifax are somewhat

different from the general run of towns both here and in Canada. The lime costs us about 45 cents per bushel and spent lime would be useless. We adopted the Hislop process two or three years ago, and it was successful with us. I do not know exactly what it costs us to reburn—at what rate per bushel—for we do not keep any account of that. We run a double set of apparatus in the daytime. One man can run the whole apparatus, and we never have more than one man in the 24 hours. He reburns, slakes, and prepares the lime for use. We lay off the kiln about two months in the summer time. The repairs so far have been very slight indeed. I think that two or three days' work is sufficient to put them into good shape. I suppose next year we will have to spend a little more; but, practically, the cost of wear and tear is very little. We use the Irish bog ore and lime. We use about 3 feet of oxide and 1 foot of lime in each box—the oxide at the bottom and the lime on top. The gas comes in at the top and descends through the box. We tried it with the lime in the bottom and the oxide on the top, but it was then more troublesome to fill the purifier, more troublesome to keep the two substances apart. We did not notice any advantage in that process, so we abandoned it and went back to the original plan; namely, oxide in the bottom and the lime on top.

As everyone knows, there is a large quantity of sulphur in the coal which we use—a much larger proportion of sulphur than there is of carbonic acid. I do not think there is quite 1 per cent. of carbonic acid in our gas when it enters the purifiers. We scrub it well. From the first scrubber we get a strong liquor; from the second a weaker liquor; and the third is the standard scrubber. Our Government Inspector's report gives us about 7 grains of sulphur in other forms, but not a trace of ammonia. It may be thought we are using a small proportion of lime as compared with the oxide; namely, about 1 part of lime to 3 parts of oxide. Our carbonic acid is practically all removed. The re-burned lime that we are using now has been in use, a part of it at least, since we commenced, three years ago. We do not find a particle of difference in the quality of the lime in respect to its purifying qualities. Of course in any little building that is going on in the works we take what lime

W. S. Greenough

we want to use from our stock of lime, and find that it makes a good building mortar, that it is as hard as cement. We get our stock of lime in the winter time by burning oyster shells; and we also get Jamaica lime which the schooners bring as ballast to Halifax. We get that sometimes at a very low price. Taking everything into consideration, we find we can use lime with our regenerative system very economically indeed. As I said at the beginning of my remarks, our conditions are somewhat different from those of others, and it would hardly be practicable for us to use lime only once, for we could not get rid of the spent lime. We are very well satisfied with the system as we use it.

Mr. F. C. Sherman—I would like to ask Dr. Wilkinson how much more lime it would take to remove the carbonic acid alone, or does he use it in connection with sulphur purification.

Dr. A. W. Wilkinson—Let me understand you. Do you refer to lime instead of sulphur?

Mr. F. C. Sherman—Suppose you wanted to use lime for removing carbonic acid, would it increase the quantity of lime if you wish to remove the sulphur in connection with it? In other words, does it take more lime to remove carbonic acid than it does to remove the sulphur and carbonic acid together?

Dr. A. W. Wilkinson—The compounds of lime are definite. You cannot make lime combine differently. Twenty-eight pounds of caustic lime will combine with 22 pounds of carbonic acid. Now, it cannot take sulphur at the same time. You cannot load it with the two. If it takes the carbonic acid it cannot carry the sulphur. So that if you have a gas which is part sulphureted hydrogen and part carbonic acid, the lime cannot carry as much of the two as it can if you have only one. In other words, 28 pounds of caustic lime can carry 22 pounds of carbonic acid, while it cannot take more sulphureted hydrogen; so that you cannot purify as much gas that contains both sulphureted hydrogen and carbonic acid, as you can if it only contains carbonic acid.

Mr. F. C. Sherman—Can anyone present tell me how many

feet of gas can be run through a bushel of lime and remove the carbonic acid after the sulphur has been removed?

THE PRESIDENT—I think that would be a very difficult question to answer, because the percentage of carbonic acid in the gas might vary.

MR. F. C. SHERMAN—Suppose that it is 2½ per cent. My experiments were made with gas which contained 2½ per cent. of carbonic acid, and I found if I wanted to remove that I had to use as much lime to remove it as I did when it was in combination with sulphur. In other words, there was no very great saving if I had to remove the carbonic acid apart from the sulphur. I tried that experiment, and found I had to increase the layer of lime continually in order to remove the carbonic acid. It finally took as much lime to remove that as it did to remove the sulphur. I would like to know if my experience tallies with that of other members who have given the matter attention?

MR. T. LITTLEHALES—Surely, there was some discrepancy in the test made by Mr. Sherman, because I think it is pretty well established that lime, having a greater affinity for carbonic acid than for sulphur, will take up for weeks, and possibly for months, carbonic acid, after it has got fouled with sulphur. Our own experience at Hamilton is rather to the upsetting of Mr. Sherman's idea. We change only about four lime purifiers per year. Last year we changed four oxide and four lime purifiers. It is true that our boxes are very large, and we have had to arrange for the lime first and the oxide second. I have not the slightest doubt that the experience of many members of the Association is in conformity with my own, and we find that we can practically drive every bit of the sulphureted hydrogen forward from the lime into the oxide. Last year it cost us $48 for lime sufficient to purify 30 million feet of gas. We could not have done this had we not been using oxide of iron. If we had taken the lime out when it was saturated with sulphureted hydrogen, I suppose it would have cost us ten times that amount. But as it was, $48 worth of lime was sufficient for 30 million feet of gas.

MR. R. BAXTER—I have said so much about the Hislop pro-

cess that I want to mention one additional point in connection with the sulphur and carbonic acid question. Mr. Littlehales has said that the lime takes up water, allows the sulphur to go on, and retains the carbonic acid. That is the reason we use oxide and lime. I believe that the Hislop process is not suitable for the use of lime altogether. Another point is this. After the lime has been removed from the box it is sometimes as black as coal, and in the course of a few hours it becomes perfectly odorless. Taking up a piece of it there is scarcely the trace of a smell, so that it is not the slightest nuisance. Of course it is not kept very long; but the odor completely leaves it.

On motion of Mr. Prichard the thanks of the Association was voted to Dr. Wilkinson for his paper.

The Association here adjourned to Thursday, October 22d, 1891, at 10 A. M.

SECOND DAY—OCTOBER 22—MORNING SESSION.

The Association was called to order at 10 A. M., Acting-President White in the chair.

THE PRESIDENT—The first business in order is the reading of papers. The next on the list is that by Prof. E. G. Love, of New York city.

Professor Love then read the following paper on

THE ILLUMINATING POWER OF MIXTURES OF COAL AND WATER GASES.

At the meeting of the Association at Baltimore, in 1889, the question was raised whether the illuminating power of mixtures of coal and water gases was higher than the average of the two gases tested separately.

In accepting the invitation of your Committee to prepare a paper for this meeting, it occurred to me that possibly a few remarks on this subject might be as acceptable as anything I could offer.

The question naturally divides itself into two parts—first, is the advantage which has been claimed for mixtures of the two gases sustained by experiment; and, second, if it is, what explanation can be offered for this increased luminosity?

My first thoughts on this subject naturally turned to a speculation as to what, from a theoretical standpoint, would be most likely to be the case; but, as might have been expected, the results were not satisfactory. This arises, mainly, from the fact that our knowledge at the present time is not sufficient to warrant us in attempting any prediction as to the luminosity of a gaseous mixture from its analysis; and yet I think this phase of the question, as well as certain collateral matters, are not wholly without interest, and I shall beg your indulgence in briefly reviewing some points which suggest themselves.

The determination of flame temperatures by experiment is attended with many difficulties, and our knowledge of this subject is very meager.

For purposes of comparison recourse is often had to a calculated flame temperature, based upon the composition of the gas and the products of its combustion. These calculations probably do not give us an approximation even to the temperature actually produced in a gas flame, for the reason that we have no knowledge of specific heats of gases at high temperature, as well as on account of the dissociation which must take place in the flame.

They give, however, a theoretical temperature which, although of a merely relative value, we may often use with advantage.

Accepting Davy's theory that the luminosity of a gas flame is due to the incandescent carbon particles, it follows that a high flame temperature which increases the incandescence of these particles will give greater luminosity to the flame. It is, therefore, often supposed that there exists in illuminating gases some direct relation between flame temperature and luminosity. There are other conditions, however, which render this relation very uncertain.

Dr. Frankland has found that ethylene, burned by itself, gives a light of 68.5 candles, and that a mixture of 75 per cent. of ethylene and 25 per cent. of oxygen has a luminosity of 74 candles. Here the oxygen gives a more intense combustion,

the flame temperature is higher, and more light is obtained. With ethylene alone the calculated temperature is 4921.6°, while the mixture with oxygen reaches 7350.8°.

The same authority has found that of the three diluents, hydrogen, marsh gas, and carbonic oxide, the marsh gas is the most valuable medium for carrying the heavy hydro-carbons, and that hydrogen is next.

A mixture of 75 per cent. marsh gas and 25 per cent. ethylene gives about 26.5 candles, while if the marsh gas is increased to 92 per cent. the mixture still has a luminosity of 17.6 candles. All mixtures of marsh gas and ethylene, therefore, furnish light, a fact in marked distinction from similar mixtures with hydrogen and carbonic oxide.

A mixture of 75 per cent. hydrogen and 25 per cent. ethylene gives about 22 candles; but when the percentage of hydrogen is increased to 90 the mixture ceases to be luminous.

A gas composed of 75 per cent. carbonic oxide and 25 per cent. ethylene gives only about 8 candles; while the mixture containing 80 per cent. carbonic oxide and 20 per cent. ethylene gives no light whatever. In other words, 10 per cent. of the ethylene is lost when mixed with hydrogen; and 20 per cent. when mixed with carbonic oxide.

The flame temperatures of mixtures of 25 per cent. ethylene with 75 per cent. of marsh gas, hydrogen, and carbonic oxide, respectively, are 4557° for the marsh gas mixture, 4878° for the hydrogen mixture, and 5127° for the carbonic oxide mixture; or the one having the highest calculated temperature is the lowest in luminosity.

Carbonic oxide consumed alone is non-luminous, but it has a high flame temperature. This arises from the fact that while its calorific power is low, the quantity of air required for its combustion is also small, as well as the products of its combustion. The high temperature raises the carbon particles of an added hydrocarbon to a greater degree of incandescence, and consequently produces a whiter light, but at the same time burns a larger proportion of the carbon without the production of any light whatever. Hence the higher flame temperature with greatly reduced luminosity.

In the case of marsh gas its flame temperature is about the

same as that of carbonic oxide; for while the air consumed and products of combustion are greater, they are counterbalanced by the much larger quantity of heat yielded. In its mixture with ethylene it has its own carbon as well as that of the ethylene to heat, a less proportion of the carbon is lost, but the flame temperature is lower and the carbon particles are not heated to the same degree of incandescence as in the case of carbonic oxide. The latter is therefore better able to carry an excess of heavy hydrocarbon than marsh gas is.

For the purpose of comparison I have taken the following analyses of coal and water gases, to which I have added a third representing a mixture of the two in equal volumes.

	Coal Gas.	Water Gas.	Mixture.
Hydrogen	39.78	29.16	34.47
Marsh gas	45.16	24.42	34.79
Carbonic oxide	7.04	28.33	17.685
Ethylene	4.34	12.46	8.40
Ethane		0.78	0.39
Benzol vapor	2.04	2.88	2.46
Carbonic acid	1.08		0.54
Oxygen	0.06	0.21	0.135
Nitrogen	0.50	1.76	1.13
Specific gravity calculated	0.4644	0.6551	0.5597
Calorific power, heat units	19233.6	13913.6	16114.4
Air required for combustion of 1 lb. of gas., lbs.	14.70	10.22	12.08
Products of combustion from 1 lb. of gas, lbs.	4.37	3.32	3.75
Flame temperature	4555.8°F.	4760.5°F.	4657.3°F.

While any comparisons of these figures must be taken with some allowances it appears that the air required for the combustion of one pound of the mixture is less than the average of the two component gases; the products of combustion are also a little less than the average, both of which are favorable to the mixture. At the same time the calorific power of the mixture is less than the average, which is unfavorable; while the calculated flame temperature is practically the same as the average of the two gases.

From a study of the question from this standpoint I have been unable to find any grounds for supposing that the luminosity of the gaseous mixture in question would be greater than the average of the two component gases.

I think I must admit that the experimental part of my case is a little weak; not from the nature of the results obtained, but rather from the number of tests which I have been able to make. This arises from the fact that it was necessary to take the coal gas at the works of the Consolidated Company, and transport it to the laboratory in cylinders under pressure. The only objection to this plan was the rather limited supply of coal gas at my disposal. The gas was transferred from the cylinder to a holder before use, and the mixture used consisted of equal volumes of coal and water gases. Extremely uniform results were hardly to be hoped for, inasmuch as the final result was based upon the tests of three different gases, with the possibly accumulated errors of each. In nearly all cases several tests were made of each gas, and the average taken.

In the first experment the coal gas tested 16.61 candles, the water gas 28.73 candles, and the mixture 23.08 candles—a gain of 0.41 candle over the average.

In the second case the coal gas gave 17.33 candles, the water gas 29.04 candles, and the mixture 23.15 candles, a loss of 0.03 candle. In this experiment the coal gas may have contained a very small percentage of water gas.

The next test gave 18.04 for the coal gas, 28.86 for the water gas, and 23.13 candles for the mixture—a loss of 0.32 candle. The last test gave 18.16 candles for the coal gas, 27.84 for the water gas, and 23.24 for the mixture—a gain of 0.24 candle.

While I shall hope to extend these experiments before arriving at my final result, I think the tests already made furnish reasonable ground for the opinion that the illuminating power of mixtures of coal and water gases is practically the same as the average of the two tested separately.

Discussion.

THE PRESIDENT—We have heard a very interesting paper by Prof. Love, and its subject is one of great interest to all of us. If any of you desire to ask any questions of the Doctor he will

remain on the platform for the purpose of answering. He will be very glad to have you ask him questions, or to hear you discuss the paper.

Mr. R. Norris—I would like to ask whether the candle power tests of the coal gas were made before or after compression.

Prof. E. G. Love—After compression. I presume that the gas suffered a little by compression, but inasmuch as the gas was transferred from the cylinder to a holder, and there equalized itself, it was a matter of no importance at all whether it had suffered a little in illuminating power during the compression.

Mr. R. Norris—Then the analyses were not made after expansion?

Prof. E. G. Love—No; the experiments were entirely separate from the theoretical consideration. I had not time when I made the experiments at the works to make a laboratory or complete analysis of the gases themselves.

Mr. A. C. Humphreys—I would like to ask to what point the compression was carried.

Prof. E. G. Love—The cylinder has a capacity of 225 pounds pressure, and I used a small hand pump. The best result I can get is about 50 pounds; and I think the most that I succeeded in getting in this case was under 25 pounds pressure. That was equivalent to three or four feet.

Mr. C. R. Collins—What was the form of the burner which was used in the test?

Prof. E. G. Love—A flat-flame burner, that known as the Bray. It was the same burner for both coal and water gas. I have used that burner for testing city gas for months, and in that follow the English practice, where they use all cannel. The flat-flame burner is used for ordinary gas, and the Argand burner for gases of 14 to 18 candles. The poorest gas we have is equal, practically, to their cannel gas.

Mr. C. R. Collins—In the course of the experiments which I have made on a practical scale, where we have made a mixture of 10,000 feet of coal and water gas, I have found it neces-

sary to use the Argand burner on the coal gas flame in order to make the resulting mixture the average of the two. Of course there were errors in my work, because the holder was exposed outside, and not under cover; but I made every correction for temperature that I could. It was necessary to use the Argand burner, because we got better results with coal gas from the Argand than we did with the flat-flame burner.

PROF. E. G. LOVE—What was the candle power of the coal gas?

MR. C. R. COLLINS—Eighteen candle power.

PROF. E. G. LOVE—You used the Referee's burner?

MR. C. R. COLLINS—We used the Sugg-Argand.

PROF. E. G. LOVE—I have followed the practice for a number of years of using the flat-flame burner. A matter of one or two candles (that is between the 18 and the 18.5 or 20) hardly warranted me in changing my burner. I think I approached nearer the same conditions in testing different gases by using the same burner, and by not introducing a possible difference in the amount of light which might be utilized from the same gas. In exactly the same way marsh gas, when tested by the Argand burner, makes a light of 5 or 6 candles, but when tested by the flat-flame burner gives practically no light at all.

MR. C. R. COLLINS—It is generally expected that coal gas will be measured by the Argand burner.

PROF. E. G. LOVE—In England it is, for that burner is the standard there—but we have no standard whatever in this country—but I think if I were testing coal gas regularly, of from 14 to 17 candles, I would use an Argand burner. When the gas produces 20 or 22 candles, I prefer a flat-flame burner. I know that it is better for the gas.

MR. C. R. COLLINS—My errors were all within a candle, and I considered that a pretty fair result.

MR. T. LITTLEHALES—I wish to ask Dr. Love whether I understood him to say that the carbonic oxide was considered a better vehicle for carbon vapors?

Prof. E. G. Love—That depends upon the way you look at the matter. If you have a little carbon vapor you had better put it with the marsh gas. If you want a whiter light, higher flame temperature, and do not care if you do burn up some of the carbon vapor, then put that with the carbonic oxide. A mixture of ethylene and marsh gas will give light at all proportions of the two. That is, the marsh gas alone, when burned in an Argand burner, will give a light, and consequently all mixtures of marsh gas and ethylene will give light. Now, if you take mixtures of 20 per cent. of ethylene and 80 per cent. of carbonic oxide, you get a flame which, in an Argand burner, gives no light whatever—showing that larger proportions of hydrocarbon are burned up and destroyed when mixed with carbonic oxide, as far as the light-giving power is concerned.

Mr. C. H. Nettleton—I would like to ask Prof. Love if there is any difference in the appearance of the mixed gases; that is, if one was pleasanter to the eye than either gas alone; or were they the same in that respect?

Prof. E. G. Love—I have long ago given up judging of gases by appearance. I did not notice any difference. I thought that they all looked very well, but I do not know that I made any comparison in that way.

Mr. C. H. Nettleton—The reason I have for asking is that there is a feeling, or a belief, among a great many people, that the best gas is made by a mixture of one-half coal and one-half water gas. That may be simply a whim, but an incident which came to my knowledge rather bears out that idea. Several years ago, when the lines were drawn very much more strictly than fortunately they are now between coal gas and water gas men, a coal gas man was brought into a room where there were three burners, one of which was good water gas, another was good coal gas, and the third was a mixture of the two; and he was asked to pick out the kinds of gas. Pointing to the mixed gas he said, "There is no use talking; the water gas makes the best light." Certainly, in my own experience the most beautiful gas—I do not mean the most brilliant, but the pleasantest to my eyes—was a mixture of the two gases.

Prof. E. G. Love—There is a blueness visible about the lower part of a pure water gas flame which is somewhat overcome by the admixture of coal gas. That may possibly have something to do with your impression.

Mr. F. Egner—I remember a time when it was rank heresy to see anything good in water gas, but I believe I may state now, without any fear of contradiction, that a mixture of coal and water gas always struck me as giving the brightest light. People who did not know the kind of gas they were looking at, would admit that much; and I believe that to-day water gas gives the whitest and prettiest light.

Mr. A. G. Glasgow—I was engaged for several years in the manufacture of mixed gas. I made about 40 candle power water gas, which was mixed with 17 candle power coal gas, in such proportions that the resulting mixture gave 27 candles. Now I am satisfied that in practice I got a higher luminosity than the calculated average of the two gases. In fact I made experiments, not perhaps carefully enough, but sufficiently so, I believe, to justify me in that conclusion. It occurs to me that the relative candle powers of the gases that are mixed make a considerable difference in the result. Perhaps my water gas was too fat to stand alone. I never calculated its flame temperature, but I am satisfied that it contained more hydro-carbon than could be burned advantageously at its flame temperature. When mixed with the leaner coal gas, my idea is that the flame temperature was such that combustion took place under conditions more favorable to luminosity.

Prof. Love—I think that is very true. Of course you can readily appreciate that there is a neutral point—that there is just the right point somewhere between the two, and if you strike that you can get the best possible result. You may get so high a flame temperature that you burn up all your hydrocarbons, and they are lost; on the other hand, you may get a sufficiently high temperature to let a part of the carbon particles escape as smoke, and consequently that is a loss. If you can get between the two you will have what I think is perfection in the way of flame.

Mr. F. Egner—I was speaking about the illuminating power of gas. I suppose nearly everyone knows this to be the fact, that a difference in the burner makes a great difference in the illuminating power of the gas that is burned. If gas companies everywhere would take a little interest in the matter, would look at their consumers' burners, and instruct consumers as to the best kind of burner to use, a great many complaints about poor gas would cease. We know, as I have said, and everybody knows, that a difference in the burner makes a great difference in the illuminating power of gas. I believe that every company ought to try to instruct their consumers in this respect. The inspectors ought to look at burners occasionally, and it would tend greatly to reduce the complaints about poor gas.

Mr. W. R. Addicks—Following in the line of what Mr. Egner has just said, the difficulty in the suburban districts around Boston has been exactly what he says. There the gas fitters invariably put on a three-foot burner in order to save gas for consumers. The whole complaint we had from consumers on the introduction of water gas was on account of the small flame. The point that I want to make is this. In the mixing of coal and water gas I think it is possible that the specific gravity may be increased in greater ratio than the illuminating power, and in that way the burner would be better adapted to pure coal gas, perhaps, than to the mixture in use, and would cause complaint. We found that the removal of the three-foot tips and substituting five-foot tips invariably gave satisfaction.

The President—Recently, while visiting the St. Paul Gas Company, I was struck with a circular hanging in front of the cashier's desk, giving some lithographic cuts of bad burners and of good burners, with the same gas—showing our old friends, the many forked and many tongued gas burners in several different phases; and alongside of it a photograph of a perfect gas burner. This seemed to me to be a very practical way of calling the attention of consumers to the difference between good and poor burners. These circulars were sent to every customer of the Gas Company on the presentation of his bill; and I was very much pleased to be informed by the manager of the Company that they had worked a wonderful result. He also said

that the Gas Company would send and put on new burners of the kind shown in the picture, at no cost to the consumer. He was much surprised to see how much interest the consumers took in the matter when it was brought to their attention.

On motion of Mr. Nettleton, a vote of thanks was tendered to Dr. Love for his paper.

Telegrams to and from the Association Hall.

The President—Is the Committee appointed yesterday to send telegrams to our sick brethren ready to report?

Mr. E. G. Cowdery—The Committee sent the following telegram to each of the three parties named—Mr. Humphreys, Mr. Harbison and Mr. Goodwin:

"The American Gas Light Association wish to tender you their sincere sympathy in your long continued illness, and their great sorrow at your enforced absence from the present meeting, which they know so well you would thoroughly enjoy. The entire Association extend to you their wishes for your speedy recovery. Signed, American Gas Light Association, per Committee."

To that telegram the following message has been received from Mr. Goodwin:

"Kindly say to the American Gas Light Association that their telegram of sympathy and condolence was received by a grateful heart. I was feeling awful blue, thinking of my inability to be with them, when it was received, and their kind remembrance acted like a panacea and makes me the more determined to get well and live.—Goodwin."

I believe that Mr. Harbison will reply to his telegram in person. No answer has yet been received from Mr. Humphreys.

Committee to Prepare a Souvenir to the Retiring Secretary.

Mr. T. Littlehales—In connection with this matter I would like to move you that a committee be nominated to prepare an address from this Association to our former Secretary,

Mr. C. J. R. Humphreys, expressing the regret of the Association at losing his services, their sympathy with him in his sufferings through which he has passed, and their hopes for the future; and that such address as the committee may think well to prepare be engrossed, and then be presented to him as a souvenir of his connection with the Association.

The motion was seconded by Mr. E. Betts, and unanimously adopted. The Chair appointed as such committee, Messrs. W. R. Addicks, Walton Clark and Charles H. Nettleton.

Mr. David Douglas, of Savannah, Ga., then read his paper on

THE MANIPULATION OF TAR FROM CARBURETED WATER GAS.

The utilization of the residual products from coal gas works has been an important factor in enabling coal gas engineers to make a better quality of gas at lower prices, and the virtual absence of residual products in a water gas plant has frequently been pointed out as an objection to that system of gas making.

The only valuable residual in a water gas plant is the tar, and the fact that it is the only one should make us take all the more care of it and endeavor to get as much return from it as possible.

In the earlier days of water gas the tar was looked upon as valueless. Where possible, it was allowed to run into the sewers and water courses, and in some instances the disposal of it was a source of much trouble. I believe there are some water gas works yet in existence where the tar is allowed to run to waste, but in the majority of works they have found that it has a value.

When water gas was enriched with naphtha there was very little tar to take care of, and that I imagine was of inferior quality. The use of heavier distillates increased the quantity and density of the tar, and the use of crude oil as an enricher has still further increased the quantity of tar made per 1,000 feet of gas, and has I believe much improved its quality.

It is possible, I think, to show that the careful collection and subsequent manipulation of the tar from a water gas plant can be made to exercise an appreciable influence upon the balance sheet of a company using the water gas process.

In the examination of water gas tars, we will notice that they are not all alike; there will be variations due: (1st), to differences in the quality of the oil; (2d), to differences in methods of gas making; large and highly heated superheaters would naturally yield a denser tar than small superheaters and low heats; (3d), the quality of tar will vary according to the point at which it is collected in the works; heavier tar will be found in the wash box and condensers and lighter tar in the scrubbers and drips in the works.

The oil which I have been using at Savannah is Lima crude oil of about 38 deg. Beaume; and all experiments recorded in this paper have been made with tar produced from this oil.

Our superheaters are rather too small, but we do not run them at higher heats to compensate for their lack of size. We endeavor to get as much heat as will fix the oil, but if there is a doubt of the exact shade of heat required, we prefer to work on the cool side and make more tar, which is easily collected and which can be worked into value, rather than make lamp-black, which chokes up everything and is a dead loss of oil besides.

In Savannah, prior to 1888, we had been using naphtha and other distilled oils and the tar was allowed to run to waste. We then commenced to use Lima crude oil, when the quantity of tar produced made it imperative that it be taken care of; if for no other reason than that we would soon have been threatened with proceedings by the harbor authorities. Doubtless our trouble was aggravated by the smallness of our superheaters, and the quantity of tar we now make in Savannah may be in excess of that made at other works, where better proportioned plants with large and properly constructed superheaters have been put in, with a special view to using crude oils.

We were then using about 4.8 gallons of oil per 1000 feet. Dipping the tar well showed that we were making apparently nearly 1 1-4 gallons of tar per 1000 feet of gas. The quantity of tar appeared to be enormous and unexplainable. I sold it in its crude condition to a manufacturer of naval pitch, and we got a good price for it. It appears that he stirred the cold tar into a mixture of hot resin products, and I understand that the quality of the article thus produced by him was highly satisfactory. Complaints soon became frequent that our tar was two-

thirds water. Next we heard of trouble from the foaming over of his hot mixtures, and, lastly, that the foam had run over, caught fire and nearly burned up the factory, and the trade ceased entirely.

Investigation showed that the tar in its crude state was really unfit for sale, because of the excessive quantity of water held in suspension, and the water would not separate from the tar in the tar tank.

Meanwhile the tar tank was filling up rapidly, and as we dare not allow it to run into the river, I was driven to look for some other solution of the difficulty.

I will not attempt to give an account of all my experiments and failures, but only relate such points as appear to be of interest.

I set up an old boiler shell on end and placed a steam coil inside of it. In this I heated the tar to about 180° F. and maintained this temperature for some hours. There was a partial separation of the water, but very slight, and the tar was still unfit for use.

I next placed some raw tar in an open caldron and fired very carefully, stirring it steadily as it approached the boiling point. The result was that just as soon as it began to boil it foamed up briskly, overflowed the caldron, got into the fire and soon was a mass of flames. I was prepared for this contingency, so no damage occurred.

I afterward tried a smaller quantity in the caldron and, by avoiding stirring, the tar got a condition of ebullition without foaming. A thermometer placed in the boiling liquid showed 232° F., and the water was assumed to have gone; but when the boiling ceased I found that about one-third of the quantity left in the caldron separated and formed a layer of water on the top of the tar. It struck me as strange that I could boil a mixture half tar and half water in an open vessel to a temperature 20° higher than the boiling point of water and yet the water was not being driven off rapidly, neither was there any foaming worth noticing. The mixture was doubled in bulk by the heat and it was all in a state of apparent ebullition. On examining the boiling mass more closely I observed that small bubbles about the size of a pea or less were constantly rising to the surface.

Some of these burst and disappeared, others seemed to shrink and to be carried down again into the boiling tar. I came to the conclusion then, and further experiments have confirmed me in the view, that the water is held in the tar in the form of small globules, each of which is encysted in an envelope of tar. These globules are so small that they are not heavy enough to overcome the viscosity of the enveloping tar. In the boiling operation already mentioned it was shown that part of the water of each globule was converted into steam and the envelope distended into a bubble which rose to the surface, where the bubble burst and the water which was in the form of steam escaped into the air, the rest of the drop being carried down again by the rapid circulation in the caldron, to repeat the operation until finally it disappeared. In other cases, if the bubble stayed long enough on the surface to cool slightly, it contracted by the condensation of the steam and went down to try and do better next time. It is evident that evaporation of water from the tar under such conditions would be exceedingly slow. If at any time while the tar was thus boiling steadily one attempted to stir it, the whole mass would immediately rise into foam and overflow the caldron. The hot tar (230° to 235°) was brought more closely into contact with the water at 212°, and steam generated so rapidly that foaming was the natural result. Noticing that, on allowing the fire to slacken and the boiling to cease, the tar and water separated and formed into layers, I tried to get rid of the water in that way, but did not find it practicable to do it in the same vessel. I found that I had three layers, viz., tar in the bottom, water next and a scum of oil on top. To boil off the water under such conditions was too tedious for anything.

I next devised and erected the apparatus as shown on sketch for separating the water from the tar.

A, is a cylinder with as many 1 1-2 inch pipes as could be conveniently placed in it to be used as flues. Raw tar is regulated to flow in from the tank B. The tar is heated in A, and rises in the form of foam and flows through the pipe C, into the settling tank D, where the water and tar separate, the water passing off through the overflow pipe E, and the separated tar, ready to be distilled, is drawn off at F.

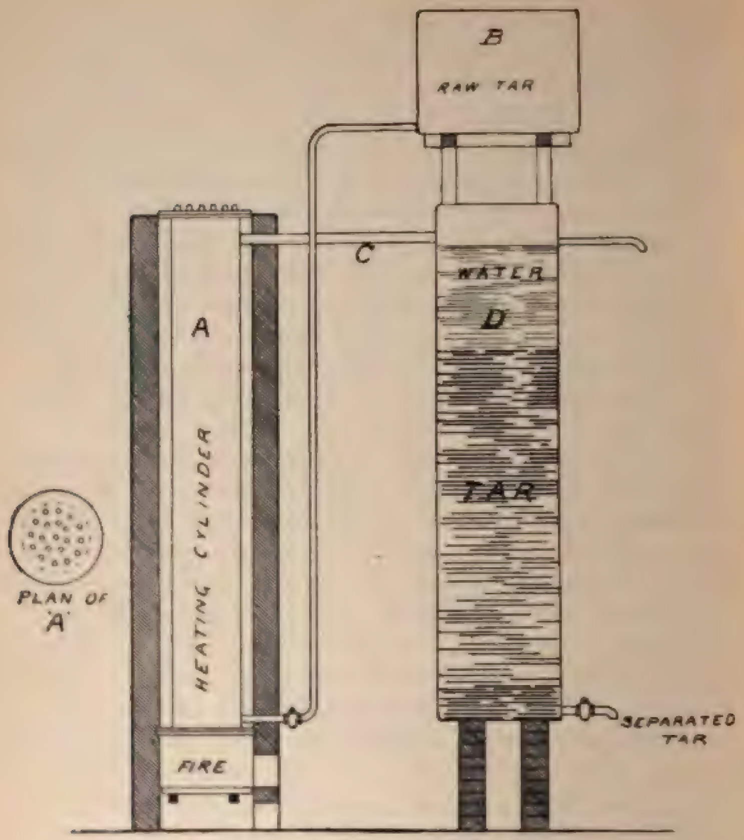


FIG. 42—VERTICAL STILL.

This apparatus I have been using for over a year and it does the work fairly well, but it is neither a very efficient nor convenient arrangement. The tar still contains from 7 to 9 per cent. of water. In this condition it might be used for some purposes, but it is too thin to be used as coal tar ordinarily is used. I could not sell it in Savannah.

My next step, therefore, was to distil the tar in a common cylindrical boiler and thus drive off all the water and as much of the lighter oils as would bring the tar to a proper consistency for commercial purposes. To do this the distillation has to be carried on until from 5 to 8 per cent. of the volume of the tar

is obtained in the form of oil, and the temperature of the tar in the still is about 400 deg. F. If heavier tar is wanted a longer distillation will give it, and if desired the distillation can be carried on until the residuum in the still consists of a hard pitch, the temperature in the still at this last stage rising to about 600 deg. F.

The oils obtained from the distillation of oil tar do not resemble those obtained from coal tar; neither are they in appearance at all like the distillates from crude petroleum. I show here a series of samples of oil taken from a careful distillation of tar up to hard pitch. The lightest oil is 30 deg. B., and the heaviest is heavier than water. It is noticeable that all the oils, even the heaviest, are very fluid and have no greasy feel whatever. Beyond the fact that a good deal of naphthaline comes over at certain stages of the distillation, I am not able to say anything about the chemical constituents of these oils. We send them all back to the crude oil tank and they are used again in gas making. I am in hopes that some better value may yet be found for some of them. The lighter oils are pretty good solvents for India rubber, although not equal in this respect to coal tar naphtha.

The distillation, of which this set of samples is a fair exhibit, gave:

Water	8.56	per cent.
Oils	44.55	"
Hard pitch	43.84	"
Unaccounted for	3.05	"
Total	100.00	"

While examining this tar during my experiments I was attracted by its beautiful glossy, black appearance. It seemed to be almost free from lamp-black. The thickened tar was exceedingly viscous and could be drawn out into threads as fine as silk when lifted on the end of a stick. Every indication showed it to be of a superior quality to coal tar. A recent analysis of water gas tar, made by Dr. Woodman, of New York, gave 4 1-2 per cent. of lamp black.

As we had not been making tar for sale for some years, the

demand for the tar when made was at first very slow. I therefore began some experiments in the manufacture of an asphalt which could be used for sidewalks and light pavements, hoping thus to make a market for the tar. I investigated the formulas of as many manufacturers of asphalt as I could get. The best of them, as far as I could judge, used varying proportions of refined Trinidad asphaltum; heavy petroleum oils; pulverized carbonate of lime, and sand.

A proportion of partly distilled coal tar was used in some instances, but my idea was that none of the manufacturers cared to impress probable purchasers with the idea that coal tar was largely used in their material.

It seemed to me that prepared water gas tar was about as good a substance as Trinidad asphaltum, and by stopping the distillation at the proper stage there need be no subsequent addition of heavy oils. I had a pretty good substitute for pulverized carbonate of lime at hand in the form of gas lime, and sand is abundant.

The making of a fine street asphalt was not contemplated. My efforts were to make a cheap asphalt which could be mixed in the gas works yard and hauled out and laid anywhere when cold. I proposed to have the article ready-mixed in the yard, and sell it by the ton to such as might have occasion to use it. As resin is a cheap article in Savannah I was tempted to use some of it, because it stiffened the tar and saved time in the distillation. I do not, however, recommend its use. It is an inferior material and detrimental to the durability of anything it is mixed with.

After many trials and failures I at last produced a very fair asphalt which answered the purpose. Its composition was

Tar..................	20 per cent. =	400	lbs.	per ton.
Resin	10 "	200	"	"
Gas lime.............	50 "	1000	"	"
Screened ashes........	20 "	400	"	"

The gas lime and ashes had to be heated and the resin and tar melted together, and a thorough mixing was essential. A better article could be made by using sand instead of ashes, or even a proportion of sand, but sand cost something and I had plenty of ashes in the yard.

I got an order from the city authorities for a trial lot. They graded the ground very nicely with oyster shells, well rolled. One ton of the asphalt covered 25 sq. yds. of surface, and it was fit to walk upon as soon as it was rolled firm and smooth. The work was perfectly satisfactory and I received further orders at a fair price, but it was evident that we were not making enough tar to meet anything like the amount of business which could be developed in this direction. The demand for tar in other directions improved and I abandoned the asphalt business.

I felt all along that this water gas tar is of too good a quality to be used only for such rough purposes as coal gas tar is generally applied to, so I turned my attention to making a black varnish which would bring a higher price for my tar than if sold simply as tar. What I sought to make was a bright, glossy varnish which would dry reasonably quick, and when dry would not scale off, but would retain a certain amount of plasticity without becoming tacky under a little excess of heat. I think we at last managed to make a pretty good material. I have samples here to show its appearance.

We use this varnish for our gas meters and find it superior to anything we had been in the habit of purchasing. I also sell it for coating cotton ties, *i. e.*, the hoop iron bands which bind the cotton bales. These are subjected to a good deal of strain and twisting. If they rust they are apt to stain the cotton, and if they are tacky the men would object to use them. This varnish quite fills their requirements, and they say is better than the regular asphaltum varnish they had been using hitherto.

My formula for this paint is very simple, but I think I tried every kind of mixture before I got it.

In distilling the tar we run long enough to get rid of some of the heavy oils leaving the tar pretty thick. Take crude rubber and dissolve it in some of the lighter distillates from the tar. Mix the dissolved rubber with the heavy tar, adding enough light distillates to thin the mixture to a proper consistency to work easily with the brush. Half a pound of rubber is sufficient for 50 gallons of varnish.

The one great difficulty in the manipulation of water gas tar,

is the initial one—to separate the suspended water from the crude tar.

In gas works where both coal and water gas is made, and both tars are run into the same tar tank there is probably little or no trouble from this cause. I have had some experiments made which show that where crude water gas tar is added to an excess of coal tar, the water gas tar is absorbed into the coal tar and the suspended water is liberated to a very considerable extent, but in all works where water gas is made exclusively, I believe this mixing of the water and tar is found to be a practical trouble.

I have already described the somewhat simple apparatus I have been using for the dehydration of the tar, and have said it was not thoroughly satisfactory.

Dr. Woodman, technological chemist, New York city, has been kind enough to make a pretty thorough set of experiments as to the dehydration of water gas tar, and has thrown a good deal of light upon the subject. I will venture to give a few extracts from his report. He says:

"The application of heat to oil gas tar, even up to 212° F., not only fails to cause a separation of the water contained but seems to actually perfect the already existing emulsion, and the tar thus treated remains unchanged for days and weeks. * * When subjected to distillation the water and oils separate; but, owing to the almost uncontrollable tendency to foam, the process becomes almost impracticable."

To tar containing 50 per cent. of water, Dr. Woodman added 50 parts more water, forming an emulsion, and after waiting three days no water had separated. To this he added 25 parts more water, making a total of 125 parts, and after standing six weeks 25 parts of water could be poured off, after gentle agitation, to collect the separated portions. "This," says Dr. Woodman, "indicates a strong tendency to form an emulsion with water, regardless of the special conditions existing in the gas-making process."

Dr. Woodman's experiments led him to try the addition of nearly everything which could be suggested, but with very little effect upon the adhesion of the water and tar. The only substances which had any appreciable effect were a strong solution

of potash and cotton seed oil. Again I quote from him. He says: "The addition of light hydro-carbon liquids, of tar oils, crude petroleum, of acids or salts having an acid reaction, is of no utility whatever. The addition of 5 per cent. potash solution and 5 per cent. cotton seed oil effects the separation of most of the water, *provided* the temperature of the tar is not above 60° F.

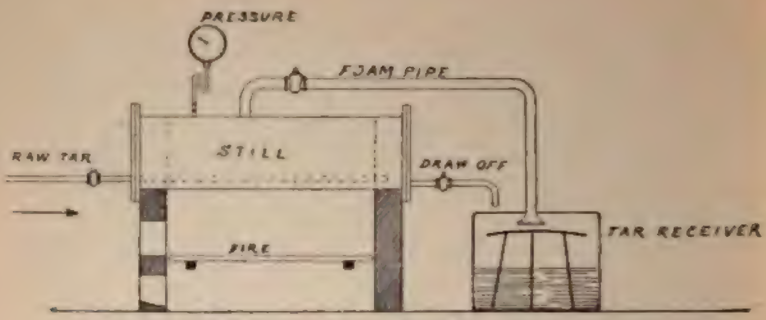
The addition of 5 per cent. cotton seed oil permits of a quiet distillation."

Dr. Woodman's experiments seem to demonstrate that the addition of chemicals to the tar was of little value in its dehydration.

Just before leaving Savannah I made another effort to effect this separation of the water in a simple mechanical manner, and this time I have come nearer to the solution of this problem than by anything I have hitherto tried.

In this experimental apparatus the still consists of a plain cylinder, fired in the ordinary way. The raw tar is forced in by a pump, a steam pressure gauge is placed upon the still. There are two outlet pipes, one from the top, which I call the "foam pipe," and which is provided with a wire gauge screen at its outlet, and one from the bottom of the still, which I call the "draw off" pipe.

Tar being pumped into the still, and fire applied, the tar, of course, foams up. The outlet cocks are kept closed until the pressure on the gauge shows about 25 lbs. The foam cock is then opened, and the foaming tar allowed to flow gently into the receiver. The bubbles are supposed to burst in passing through the wire gauge, but if any do escape, the falling upon the baffle-plate in the receiver is supposed to burst them. Any tar or water which separates in the still is removed by the draw-off cock. Meanwhile, fresh tar is being pumped in, and the whole process becomes continuous. My impression was that most of the water would come off through the foam pipe in the form of steam, but I find that a considerable proportion of the water in the tar is separated in the still itself, and can be removed at the draw-off pipe. Two tests made with this apparatus gave the following results:



No. 43.—HORIZONTAL STILL.

Test No. I.

Dehydrated tar in receiver............	46.5	per cent.
Water collected	24.5	" "
Water evaporated....................	29.0	" "
	100.0	

Test No. II.

Dehydrated tar in receiver....	51.0	per cent.
Water collected........	24.0	" "
Water evaporated..........	25.0	" "
	100.0	

Subsequent distillation of this dehydrated tar showed that, practically, all the water had been removed; less than one per cent. of water was found in it. It appears to me that this apparatus indicates a solution of this troublesome problem.

Just how much tar is made, or should be made, per 1,000 feet of gas in a water gas plant using crude oil is a question I am not prepared to answer. We would like now to put all the oil into the gas, and make no tar at all; but if tar should prove to be worth more per gallon than crude oil, we may yet change our minds in that respect.

In 1888, when using about 4.75 gallons of oil per 1,000 feet, we made about .6 of a gallon of tar per 1,000 feet, not counting the water in the tar.

In 1891, using about 4.5 gallons of oil per 1,000 feet, we make

about .35 of a gallon of tar per 1,000 feet. Of this, .1 of a gallon goes back to the oil tank in the form of distillate, and the tar made for sale amounts to just about one-quarter of a gallon per 1,000 feet of gas made.

These quantities appear trifling in amount, but if we can only demonstrate that the water gas tar is of superior quality, and in consequence can find a market for it at a higher price than we hitherto set upon it—and I think we can—then a quarter of a gallon of tar, if worth 20 cents per gallon, would give us 5 cents per 1,000 feet. Figuring at any price in these days of keen competition, when every fraction of a cent has to be counted, it is evident that we cannot afford to despise our residual of tar from a water gas plant.

President Harbison Arrives.

The Chairman—Before proceeding to take up the discussion on the paper just read by Mr. Douglas, it is my very great pleasure and privilege to announce that at last we have with us our President, Mr. John P. Harbison. (Applause). Mr. Boardman will please present our President. (Mr. Harbison was escorted to the platform by Mr. Boardman). I now have the pleasure of turning over the gavel (and I know you join with me in that pleasure) to our chosen President, Mr. Harbison.

President Harbison—Fellow members of the American Gas Light Association: I cannot tell you what my feelings are at this moment, or what they have been during the past few weeks, while I have been conscious, in regard to this meeting, and the privilege of meeting with you, or the prohibition by my physician that I must not come. A week ago yesterday, he gave me that permission under certain conditions. Those conditions I propose to comply with to the letter, so that my stay with you to-day will not be very long. As I crossed the walk yesterday from my office door to my carriage to take the train, a messenger boy put into my hands a dispatch from my brethren of this Association. It pretty nearly unmanned me. I knew I had the regard, and to a degree the affection, of many of the members of this Association, but to have a message in the language in which that was couched was too much for me. Breth-

ren, my heart responds to your sentiments. I feel grateful, and can simply say in connection with it, God bless every member of this Association.

Three weeks ago, or more, in answer to an earnest inquiry of my physician, he positively forbade me thinking of the business affairs of this Association, and said I must not think of commiting anything to paper as an address to be delivered to you. As soon as I was able I wrote to my beloved friend, Capt. White, your President-elect, and turned the business of the Association over to him so far as the President's duties were concerned.

As some of you well know, a year ago, when you were kind enough, and generous enough, and compassionate enough with yourselves, to elevate me to this honorable position, my beloved brother and friend, C. J. Russell Humphreys, consented to serve as Secretary for this year, as a personal favor to me.

We journeyed together to Zanesville, in March, to attend the Ohio meeting. We journeyed together to Louisville,in May, to attend the Western meeting. Soon after our return that beloved brother was laid on his back, and some of you may know how near the point of death he has been, and he is still unable to be with us. Thus your two executive officers have been within the year unable to perform their duties.

It became evident a week or more before I was taken ill that Mr. Humphreys could not be with us to do his duties. His worthy and efficient brother volunteered previous to that, and at that time, to help us in any way he could, even so far as to undertake to perform the duties belonging to the Secretary. I at once sent him an official appointment, as acting Secretary and Treasurer, to serve until his successor was elected and qualified. How well he has performed that duty on a moment's notice you all know. Probably no other member of this Association—I doubt whether there is a single one here—could have perfomed that duty as Mr. Alex. C. Humphreys has done. (Applause.)

There are two or three things that I would like to say to you. The members of this Association will bear me witness, that since its organization, or very soon after its organization, when I became a member, until a year ago in Louisville, no member in Association meetings, ever heard me say a word that was par-

ticularly favorable to water gas I had been conscientious in my views. I knew what I was doing with coal gas. Water gas to me was theory, and somebody else's results. Practically, I knew nothing about it. At the Louisville meeting it became known that I had recently, or a little while before that time, put in a water gas plant. I had only started it ten days before I went to that meeting. I could not give any results, and I was hardly ready to tell why I had done it; but I promised the Association then that if I lived until this meetiug and attended it, I would tell you my reasons and general results; and I like when I make a promise to keep it. That was one very strong point in urging on my physician that he should permit me to come down here and be with you an hour to-day. We have in our city, as many of you have—some of you owning it yourselves and some of you competing with it, the plant being owned by other parties—electric light plants. The American people are great for new things; and when the electric light came around they went for it, and went for it pretty strong; the gas companies suffered in consequence. We did to a considerable extent. We lost our entire street lighting. We have not a street lamp left, and have not had one for two or more years. A large number of private consumers introducing the electric lights, put out gas. It became necessary to meet that competition. Economy was introduced at every point where it could be in the manufacture and distribution of gas. The very best results that might be obtained we tried to get, and we thought that we were doing well; but the light from the new electric lamps would outshine the gas that we could make from coal. I introduced naphtha as an enricher instead of cannel coal to whiten the light. I was not able to get above 18 candle power, and not smoke. As against the 25 or 30 so-called candle power incandescent light, gas would not compete. They put in their lights by contract, the prices being the price at which gas was sold the previous year, and people could use it all they wanted.

We lost a large number of our consumers. It became evident to me that something more must be done. I had had various parties with me urging that I put in a water gas plant. One distinguished man in the business called on me and urged me, as he had done several times before, to introduce it, but did not

succeed, my statement to him being, "when you can demonstrate to me the saving of ten cents a thousand cubic feet, with the receipts for the dividends filed in the safe (for that is where my expense ends in making and distributing gas) better than I can do with coal gas, I am ready to consider a contract with you." That gentleman has not, to my knowledge, been in Hartford since, and that was six or seven years ago. I put in a stack of regenerator benches. I got good results from them, and they are doing well. A representative of a large concern engaged in the introduction of water gas called upon me in the line of business, and wanted to call my attention to their system of making water gas. He stopped at my up-town office, and talked with me there. I said to him, "Before we talk business, come down with me to the gas works and see what we have got there, and what we are doing, and see our books. Let me show you what our gas has cost us to deliver, what results we are getting, what our candle power is, and then tell me what you can do for us with your system." He did so. He is a member of this Association. He is in this room to-day—and second to no other member in intelligence and activity. When he had examined the works carefully, he said, "I will return to my superior officer, and tell him that there is no business for him in Hartford." I continued my investigation with regard to what was being done with water gas; and I became satisfied that we could make an improvement in our business by the introduction of a water gas plant, not by any means discontinuing coal gas, but to make a mixture of the two gases. A year ago last spring we made a contract for a plant having a capacity of 500,000 cubic feet guaranteed. We are making to-day, and every day, more than 325,000 feet in 24 hours with *one-half* of that apparatus in use. We have made, and used that gas every day since about the first of October a year ago. We make the two gases. As the water gas comes in a crude state from a relief holder it passes through a station meter, which we bought for the purpose of measuring what we were using, and connected it with the take-off pipe from the hydraulic main, at a distance of 40 feet from the hydraulic main, and there unite the two gases before they reach the exhauster. We have wintered that gas and have summered it. We have had a change of

40 deg. of temperature within 24 hours. We have increased the candle power 23 per cent. over what we were doing with coal and naphtha gas, using naphtha in the retort, and I have not seen the gas in my office (half a mile from the works) in a Jones photometer below 22 candles in a year, varying from 22 to 23½ candles. Two years ago, when we had trouble with our gas, the city had an inspector appointed, and the inspector has made monthly tests and reported to the Common Council every month since that time, until the meeting that was held a week ago Monday night. His last test was made on the 30th of September. On his report being read, it was unanimously voted by both branches of the Council that the services of the city inspector be dispensed with, that he make no further test; that the quality was so good, so uniformly good, that there was no necessity for it, and they need not be at the expense. I knew nothing about it. I had then been in a sick bed for more than a month. Therefore, that vote was not carried through by any log rolling on my part, or any knowledge on the part of any member of our Company that such a thing was proposed. There is not a consumer in the city of Hartford within my knowledge that is not entirely satisfied with the quality and with the service. We have increased largely since the first 60 days after we put in the water gas, the increase being continual and regular. I believe that the mixture of the two gases makes a gas and makes a light that is superior to either coal or water gas alone, and increases the light without making a smoke. We have not had a complaint of the smoke from a consumer, to my knowledge, in 12 months, where the burners were good, and I do not believe there will be any. We have not had, until the very cold weather of two weeks ago, within my knowledge, a complaint of naphthaline in any service of the city during the time we have been using water gas. We had a very severe cold spell ten days ago, and I was informed that some five or six cases had been reported where there were slight stoppages by naphthaline at the meters.

These are some of the results that we have obtained in the year; and we believe that any company that wants to furnish the very best light to its consumers cannot do better than put in a water gas plant, to be used in connection with its coal gas

plant, and use the two together. I believe such will find it profitable for themselves, and greatly beneficial to their consumers.

We are selling coal tar to-day, and have been all through the summer (excepting a contract we made at the beginning of summer with a party that we have served for 40 years, they paying us $3.25 per barrel) at $5 per barrel, and have not been able to take the orders that have been sent us at that price. We have sold coke at six cents per bushel for years. We are now selling, and have been for ten months, at ten cents per bushel.

These are some of the results that we have obtained. We believe that we are running our plant fairly well; at any rate, the chief executive officer of the Company who put in our apparatus for us, has informed me that he had not in mind then any party that showed any better results with his apparatus than we were obtaining.

Brethren, I now have redeemed my promise made to you a year ago, and if my experience is of any value to any of you I shall be glad of it. (Applause.)

Installing the Officers Elect.

The President, continuing—Will the Secretary kindly inform me of the result of the election of officers on yesterday? If there is anything that has been a burden on my heart while I have been ill it has been that I could not be here to declare the result of the election of my successor, and to properly introduce him to the members of this Association as your choice to preside over your destinies during the coming year. I knew what your choice would be. It could not be otherwise. By your kindness in postponing the introduction of officers-elect till to-day I have the pleasure of making this introduction. I learn that during your meeting yesterday you had the pleasure of adding something like 50 names to your list of membership. It is particularly gratifying to me to hear of this large increase of active, energetic, intelligent, working men to the ranks of the American Gas Light Association. To those who have been bers heretofore, your selections of yesterday need no in-

troduction, but to the new men who come in for the first time with us, your selections of officers need an introduction, in part at any rate. That is one of the pleasant features of this Association. While I have been so ill, that has been one of the great comforts to me—that my acquaintance was so pleasant with the members of this Association, as with those of all the other Associations with which I have the honor of being connected, that we are as a band of brothers, all striving together in the same cause. When this Association was organized I doubt if there are half a dozen men in this room who could have gained an entrance into the Manhattan gas works of this city, or into any gas works of any other city.

They would have found the gates locked, and a flaming sword there to keep them out. Now every gas works in the land that I know of is open to any man who is a gas man, and a member of this Association, on his presenting himself, and saying who he is, if he is not already known. Our books are open to each other, and all the information that we are possessed of is cheerfully given.

I find by the report of your doings yesterday that your Committee on Nominations presented the following names for your consideration, and that you unanimously, through your Secretary, passed the ballot of the Association for the names presented.

If there is any man in the profession who does not need an introduction to you, that man is Captain William Henry White. (Applause.) Brethren, I know William Henry White as few of you do. He has been an intimate friend of mine for many, many years. I have traveled with him, and I know him thoroughly. He is a man without a weak point as a man, and as a friend; a man who has never been known by any gas man, or by anybody else within my knowledge, to know of or to meet a man that was in need of assistance, or of a word of advice, but his hand was open, and his heart was open, and his pocket was open to relieve him, and to help him to the extent of his ability. His name is proverbial for good things amongst us; and this Association has done itself honor in calling to the office and position of its President Captain William Henry White. I would have been willing to have counted the railroad

ties between Hartford and New York, and to have walked here rather than had any member of this Association have the honor of introducing him to you as your President-elect other than myself, I being your President; and I would be willing to put in another four or five weeks in bed, if it was necessary (as I trust it will not be), to have this honor, which now, and now only, can come to me. I have now, without any further remarks in regard to it, the extreme pleasure and personal gratification of presenting my beloved friend, and your friend, William Henry White, as your President elect.

Response of Captain White.

President-elect White:—*Gentlemen*—As our President has said, I feel that I need no introduction to you, and I may rightly deem this to be sufficient response to the words spoken by your President, and in recognition of the honor you have put upon me. The full heart may not be relieved of its tension through the agency of the voice, and were I to talk to you a thousand years I could not give you even an idea of how proud I am to at last fill the highest position in your gift, feeling, as I well do, that I have not won it through any great merit as an engineer, and that no man who sits within the sound of my voice considers me in the light of a great professional success. But as your friend, as your comrade, as one who, sometimes with a heavy heart, never permitted his trouble to weigh upon your liveliness, I feel that you have arrived at the conclusion which we are told sometimes is arrived at by a woman, who, in order to get rid of an importunate lover, marries him. So I think you have concluded at last that you have had me in the guise of king's fool long enough; that if it were possible for me to have a grave and serious moment you would lift me to the dignity of the place to which you have chosen me and say, "Stand there, little fool; look wise if you can; rattle your cap and bells as you may, but remember the king's eye is always on you."

I shall try, brethren, to fulfill the duties of this office with that fairness which springs from the desire to serve you faithfully, and all that I ask in further favor at your hands is to guerdon me in that earnest support with which you have so

staunchly sustained my predecessors in this office of honor and responsibility.

PRESIDENT HARRISON—Brethren of the Association: You have made one step further in progress, and have promoted to the first Vice-Presidency a man whom we all love, a man whom we all admire, a man who has served the Association in season and out of season since he became a member—a man eminently qualified for the position to which you have called him, and from which a year from this time, if he is alive and is spared, you will promote still further. I have great pleasure in introducing to you our brother, A. E. Boardman, of Macon, Georgia, as your First Vice-President elect. (Applause.)

RESPONSE OF MR. BOARDMAN.

MR. A. E. BOARDMAN—Gentlemen of the Association, and fellow brethren of the craft: I have very little to say, except to thank you for the promotion which you have given me, and to thank our worthy President for the kind words in which he has introduced me. Some men inherit greatness, others acquire it, and others have it thrust upon them. I belong to the latter category. I assure you, with all my apparent bravery, it is with extreme diffidence that I accept a position of such honor and trust in such a body of men, feeling as I do that I do not deserve it, and that it is given me because I represent a section of this country which we all feel is a common country; and because I was one of the first from that section to come to your notice on account of my glib tongue. I thank you for your kindness in electing me, and I promise to do the best of my poor ability to merit your esteem. (Applause.)

PRESIDENT HARRISON—You have gone one step further, and although when this Association was organized it was confined to gentlemen connected with the profession within the territorial limits of the Star Spangled Banner, since that time, in a feeling of brotherly love and kindly regard for our neighbors, and because our neighbors were good fellows and able and capable, and we wanted them of us, and they, in a generosity and kindness of heart, wanted to be with us and to do us good, and to get good from us; we have gone over the line to take in a

number of our brethren from over the border, and it will be but a short time before they will all be with us in fact. (Applause.) You have called to your Second Vice-Presidency that eminent gas engineer, that man who is always ready to do his full duty, always in attendance at our meetings, always taking active part in them—Brother William H. Pearson, of Toronto. (Applause.)

Response of Mr. Pearson.

Mr. William H. Pearson—Gentlemen of the Association: When you so very kindly, in my absence last year, elected me to the honorable position of Third Vice-President of this Association, I felt as I can hardly now express. I was exceedingly grateful for the high honor conferred upon me. I thought that after having elected me to that position I would have gone no further and be quietly allowed to retire to the ranks of the Association; but when you yesterday so kindly elected me to the position of Second Vice-President, while I felt extremely grateful for it, I must confess I experienced a feeling of very great trepidation as I thought of what might possibly follow. I do not accept this as a position given to me because of any particular merit in myself, but rather as an act of kindly consideration and as an act of brotherliness toward the country to which I belong. (Applause.) I thank you that you have done this honor to Canada, and as such I accept the honor, and not as a personal matter. I do not consider that my attainments, that my work, entitle me to such a position, but I accept it for the reason that I have just stated, and I assure you I shall perform any duties in connection with that position that may be given to me, to the very best of my ability.

President Harbison—If you ever had a Committee on Nominations who have done their whole duty, this year has been the time. There was a wide field for them to cast their eyes over and a large number from whom to make a selection of capable men to raise to the position of Third Vice-President and in their wisdom and judgment they saw fit, and wisely so, to make an entirely new departure, an election to the position of Vice-President being in direct line by promotion to the Presidency. Since our lamented and beloved friend, General Roome,

occupied the position of first President of this Association to this time you have always had grey haired men in the Chair. Your Committee has seen fit to do otherwise, and as I said, in my opinion, wisely. New members are coming in, and for several years they have been and still are largely young men. A majority, and I think quite a considerable majority, of our membership are comparatively young men. Perhaps some of the grey haired ones like myself will be very glad to be on the benches and to have young men at the helm. Your Committee have very wisely presented, and you have approved, as your Third Vice-President, the name of one who, since his connection with this Association, stands first and foremost in activity and energy in preparing valuable papers for the Association and doing work for it continually. I have the extreme pleasure of presenting to you Mr. Walton Clark. (Applause.)

Response of Mr. Clark.

Mr. Walton Clark—Mr. President, though they embarrass me almost out of the power of expression, I thank you for your kind words. Gentlemen, I cannot understand the indifference that is sometimes felt or assumed in the face of an expression of confidence such as you have given my unworthy self. An honor striven for, save by effort to be worthy of it, ceases to be an honor in the attainment; but when, by the unsolicited votes of his associates, a man is raised to the position of Vice-President in a body such as the American Gas Light Association, if he fails to feel, and to take every opportunity for expressing, a deep sense of honor and gratitude, he is differently built from your Third Vice-President elect. (Applause.)

President Harrison—The most difficult part of the duty of your Committee in preparing a list of names to be presented to you, was to select the name of some one who could occupy the position of your Secretary and Treasurer. As they looked back over the past years and saw how faithfully and thoroughly and completely that work had been done by Secretary Humphreys, the selection of a man to be his successor was not an easy thing —particularly as there are so many connected with the Association who are qualified to a greater or less degree to occupy the

position. You have a distinguished New Englander who has occupied the position of President, who has done himself credit and you credit as your presiding officer. He is a man beloved by us all and deservedly so. He will stay by you during the day, and if you are at all indisposed he will stay by you during the night. Indeed he would stick closer than a brother, if it were necessary. In the ordinary course of nature there was given unto him a son, and knowing to what attainments he had reached, and expected yet to reach, he wanted to send his own name to posterity, and so brother A. B. Slater, of Providence, R. I., my near neighbor, named this son after himself, and he grew up a chip of the old block, only more so ; indeed you might say the old block with a chip added. (Applause.) Your Committee have unanimously selected that worthy son, who has within quite a recent time become a member of this Association, but during his membership we have learned to love and to esteem him—not simply because of the virtue, ability and qualifications of the father, but because of real merit and worth in himself. I have great pleasure in introducing to you brother A. B. Slater, Jr., as your Secretary and Treasurer elect. (Applause.)

Response of Mr. Slater.

Mr. A. B. Slater, Jr.—Mr. President, and gentlemen of the Association : I sincerely thank you for the honor you have conferred upon me, and the confidence reposed in me, and hope that I shall not show that your confidence has been misplaced. After the execution of the duties of the office by so able a person as my predecessor, and especially after the execution of those duties so faithfully and ably as at this meeting, I have great misgivings as to the outcome of your selection. But while I think that the duties of the Secretary are engrossing, still upon looking over the faces before me, I am satisfied that the co-operation of the members will help the Secretary and will keep the duties of the office from becoming onerous ones. Our President referred to the older members as being relegated to the bench, but I think that we are not ready to have them thus disposed of. In fact some of them have not yet been admitted to the *bar*. (Applause). The President has referred to

my membership in the Association as being very short. It is very short indeed. I all the more appreciate the honor that is conferred upon me in consideration of that fact and that you have put practically a youngster into the office. Those who have spoken before me, headed by our well-known brother White, are all men who have been selected for, and are expected to be, good speakers. But your Secretary is supposed to be a man of silence. Therefore, gentlemen, I can only thank you for the honor you have bestowed upon me. (Applause.)

PRESIDENT HARRISON—You have in addition to what has been already reported elected the following named gentlemen as your Council:

JOS. B. CROCKETT, San Francisco, Cal.;
C. J. R. HUMPHREYS, Lawrence, Mass.;
JOHN YOUNG, Allegheny, Pa.;
IRVIN BUTTERWORTH, Columbus, Ohio,

for the term of two years.

Last year you elected, and their terms do not expire for one year yet: Messrs.

C. H. NETTLETON, Birmingham, Ct.;
JAS. SOMERVILLE, Indianapolis, Ind.;
A. W. LITTLETON, Quincy, Ill.
F. EGNER, New York.

These gentlemen I declare members of the Council for two years and one year respectively. I believe that completes your elections.

And now, brethren, while I am still with you, I desire to refer to another matter. Some time ago it was proposed to hold what is known as the World's Fair, at some point in this country, to properly commemorate certain events in the history of the country. After a time, through various manipulations, it was decided that that Fair should be held in the city of Chicago. The gas industries of this country and of this continent, having grown enormously since the Centennial Exhibition in Philadelphia, it was thought wise by members of the various Associations that an organized effort should be made, that the gas industries should be fairly represented at the Fair. In further-

ance of this object the New England Association (which is the parent Gas Association) named a committee to represent them in connection with similar committees to be appointed by the kindred Associations. At your meeting following the New England meeting, this Association appointed a committee to represent them on that general committee. The Western Association later on appointed a committee to represent them on the general committee. That was a year ago, last May. The Ohio Association did not hold an annual meeting until last March, and they at that time appointed an honored member of their Association to represent them on that general committee. So that, in the month of March of this present year, the four Associations had appointed their committees to represent them on a general committee in furtherance of this laudable object. Previous to this time, and after the meeting of the Western Association, I had the honor of being appointed Chairman of the general committee. No meeting of that general committee could be held earlier than the month of May. That meeting was held in the city of Louisville, during the time of the holding of the Western meeting. These committees were appointed by the four Associations with the express understanding that their personal time and services were to be gratuitously rendered; that they were not to be compensated for their labors individually in any respect; but that the actual expense incurred by the committee should be borne pro rata by the various Associations. At that meeting of the General Committee in Louisville the whole subject was thoroughly talked over by the members present. It was not deemed advisable, because of the expense, to have all of the members of the committee visit Chicago to see the General World's Fair Committee as a first move, as it was thought that the expense would be too great, and we knew that the treasuries of none of the Associations were overflowing. So that the general committee appointed an executive committee of three, from its own members, composed of the Chairman, the President-elect of this Association, Capt. White, and the Third Vice-President, Mr. Walton Clark, to represent the general committee to go to Chicago and interview the World's Fair Commissioners in behalf of the object we had in view. Previous to that time I had talked with the Hon.

Leveritt Brainard, of Hartford, who is a Commissioner for the State of Connecticut to the World's Fair, and a personal friend, and he assured me that anything in his power that he could do he was ready to do in behalf of the object I had at heart. I had several conferences with him, and he wrote to the President of the World's Fair Commission, stating what our objects were in a crude way—we had not very clearly defined ideas of our own at that time—and in due course of time he received from the Secretary of Installation a letter outlining, so far as he could, what he understood to be the ideas of the World's Fair Commission. Immediately after the receipt of that letter Mr. Brainard decided to go across the water for a vacation. He handed me the letter from the Secretary of Installation, and asked me to follow the matter up as I might think best. I conferred with my associates of the sub-committee, and we decided that as soon as it could be arranged between us we would visit Chicago. My associates on this executive committee, Messrs. White and Clark, are, as you know, very active men, and it is not every day that they can leave their private business to go off for a number of days on the official business of this Association, or a number of Associations; and it so happened that when one could go the other would find it impossible to go, and vice versa. I had forgotten to state that soon after our return from Louisville in May, the Secretary of this Association (who was a member of that general committee) was laid on a bed of sickness, and we delayed week after week, hoping that we might have the benefit of his counsel and judgment before starting. After a while we reached the point where we found that Mr. Clark could not, for at least thirty days, go with us to Chicago; and he advised, as the time for this meeting was drawing near, and whatever could be done ought to be done without any further delay, that Capt. White and I go alone. And so Capt. White and myself went to Chicago, and urged, with all the ability we had, the importance of the interests in which we were engaged, and the duty of the World's Fair Committee, to give us a fair show. Our opponents of the electric light industries are men of great wealth apparently, and are very liberal in spreading it around whenever they have an object to gain; and they had in a munificent manner volunteered to do considerable in Chicago

by way of putting up a building of their own. They managed in some way to get the inside track in the lighting of the buildings, and so forth. As was suggested at our Association meeting, we had not a great deal of wealth available; and we did not see where we could raise the money—$100,000 more or less—to put up a building for the gas exhibits, and did not know to just what companies we could apply for money with success. I might say, in this connection, that I had from a distinguished gentleman, a member of this Association, his personal assurance of an earnest effort in our behalf for a very considerable portion of this money necessary; but getting the last $50,000 would be where the shoe would pinch; and so that kind offer has not yet been made available, because we had no definite plan that we could lay before the parties whom he represented. We visited the Secretary of Installation, and laid before him our views, and he, in turn, gave us his, which, when simmered down, were to the effect that the Commission would provide for the gas industries a certain amount of space—and we mentioned to him what, in our opinion, would be a sufficient space for the exhibits that might be made by the representatives of those who were engaged in business in connection with our industry. He asked us to reduce our suggestions to writing, and he would present them to the Commission at their next meeting. He prepared such an application or communication in behalf of the gas industries, and as a committee representing the Associations, we subscribed our names to it. Then Capt. White presented that communication to Mr. Hurst, the Secretary of Installation, and since that time he has seen him again. Capt. White made a report to you yesterday of the doings of your Committee; and I am personally very much gratified to know that this Association heard the report, accepted it, and discharged your committee.

The Association then took a recess until 2:30 P. M.

Second Day—Afternoon Session.

The Association was called to order at 2:30 P. M., Acting President White in the Chair.

THE PRESIDENT—As your Committee has reported two answers received to the telegrams sent to our sick members, the Chair has now the pleasure of announcing that the following telegram has just been received from Secretary Humphreys:

"American Gas Light Association—Accept my hearty thanks for your kind message of sympathy and my best wishes for a pleasant and profitable meeting. C. J. R. HUMPHREYS."

PLACE OF NEXT MEETING.

THE PRESIDENT—I believe the Committee on selecting the place for the next meeting, of which Mr. Scriver is Chairman, is ready to present their report.

MR. J. F. SCRIVER—Your Committee report that we have received three invitations for the next meeting; from San Francisco; from Montreal, and from Boston; and your Committee beg to report they recommend the city of Boston for the next place of meeting.

On motion of Mr. Egner the report of the Committee was received and the recommendation adopted.

COMMITTEE OF ARRANGEMENTS.

THE PRESIDENT—I presume that some gentleman will make a motion with reference to the appointment of the usual Committee of Arrangements. The Chair will be pleased to entertain the motion.

MR. F. EGNER—I move that the Chair appoint a Committee of Arrangements, consisting of five members, for the Boston meeting.

THE PRESIDENT—If there is no objection the Chair will appoint such a committee during the course of the afternoon.

(The Chair subsequently named the following as the Committee of Arrangements for the Boston meeting: M. S. Greenough, Chas. D. Lamson, Fred. J. Davis, Dr. Robt. Amory and Robt. B. Taber.)

DISCUSSING THE PAPER BY MR. DOUGLAS.

THE PRESIDENT—On receiving Mr. Harbison this morning we just closed the reading of a very interesting paper by Mr. Douglas, the discussion of which was interrupted by the entrance of President Harbison. Mr. Douglas is now with us, and will kindly come to the platform and be prepared to complete his remarks, if not already completed, and to answer any questions which any gentleman may desire to ask him.

MR. D. DOUGLAS—I have almost forgotten what I had been intending to say further on the subject; but I have some samples here of various things which I would be glad to have any gentleman examine later on. There are some little matters here which I think might be of interest, especially to those who are more particularly interested in chemistry. If there are any questions connected with this subject that I can answer I shall be glad to do so.

MR. A. S. MILLER—Can you tell me the temperature of your separating tank, where the tar and water are originally supposed to be separated, running from the scrubbers and wash-boxes?

MR. D. DOUGLAS—I am not able to tell you the exact temperature of the water that flows from the box, but it is pretty hot; it is pretty well toward the boiling point. You cannot keep your hand on it; I think it is about 200°. I did not look at the thermometer.

MR. A. S. MILLER—Concerning the asphalt I would like to ask if you used it for paths only, or for road beds as well.

MR. D. DOUGLAS—I only use it for paths. As I explained in the paper, we did not have enough material to make asphalt for roadways. I proposed to find enough for the sidewalks, but I did not have enough even for a sufficient business in that direction.

MR. A. S. MILLER—How long have they been in use?

MR. D. DOUGLAS—Those I refer to have been in use for a year and a half, or two years, and are perfectly good. They are laid in streets where we have a good deal of travel.

Mr. W. H. Pearson—The question of the disposition of tar is one that every water gas man who is using any heavy oil is very much interested in. At our works we have been through all the difficulties that Mr. Douglas states he went through, in order to eliminate the water which is held mechanically (not chemically) in the tar. I will ask our Superintendent, after I have got through with what I have to say, to describe the process adopted by the parties to whom we have disposed of our petroleum gas tar, as he has witnessed the operations, whereas I, for various reasons, have not been able to do so. Am I right in understanding Mr. Douglas to say that with the smaller of the two superheaters he got about one-fourth of the tar and of the amount of oil used?

Mr. D. Douglas—No, sir; I said we found in the tar tank about one-fourth of the quantity of oil used *apparently* as tar. Later investigation showed that a very large proportion of that tar was water; and, finally, I think left about six-tenths of a gallon to one thousand feet—that was tar, without water.

Mr. W. H. Pearson—I thought that that was due to your using another superheater.

Mr. D. Douglas—No. Perhaps I did not make myself clear as to that. We were dipping our tar tank in the ordinary way, and supposed that what was giving the color on the dripping rod was tar; and it showed us one and one-fourth gallons of tar made from 1,000 feet of gas, which struck me as being altogether unwarranted. Later on, by eliminating the water, we showed only 0.6 of a gallon of actual tar in the tar well per 1,000 feet of gas. Our present working gives us one-third of a gallon of tar per 1,000 feet of gas made. I put in four and one-half gallons of oil, and I get back one-third of a gallon of tar.

Mr. W. H. Pearson—As to what tar we are getting now, while using the U. G. I. Co.'s improved Lowe process, I cannot speak with accuracy, but should say about one-tenth of the quantity of oil used. I may say that we are getting about one-seventh, when operating the original Lowe process without the carbureter. Did I understand Mr. Douglas to say that by mixing the tar from the water gas plant, (where both coal gas and

water gas were manufactured,) with the coal gas tar, the water was distributed through the whole, and that no difficulty arose except that the tar was a little thinner?

MR. D. DOUGLAS—I think I stated in adding the water gas tar to a larger quantity of coal gas tar, the coal gas tar absorbed a good deal of the water gas tar and liberated the water; consequently, distillation was possible, as the water did not give any more trouble. That was not done in my works.

MR. W. H. PEARSON—Is the gentleman here at whose works that was done?

MR. D. DOUGLAS—I have made a good many inquiries from gentlemen who are using both processes. I made an experiment myself with the coal tar, and proved that that was the case, in my own office, but not in my works. I am perfectly well satisfied that it works so in my office; and other gentlemen using it tell me that with them it works in the same way.

MR. W. H. PEARSON—Parties in Toronto have accomplished, I think, pretty thoroughly what you have nearly accomplished with your apparatus, and I think in a simpler manner; but I prefer to leave the explanation of that to our Superintendent, as he can give it more accurately than I can, for I have not personally seen the process in operation.

MR. F. EGNER—The paper read by Mr. Douglas I consider to be one of the most valuable and practical papers which we have had before the Association in some years.

MR. W. H. PEARSON—I think a little additional light can be thrown on the subject, if our Superintendent can get over his native modesty and state what he knows about it. I think he can tell something which will be interesting to every water gas man here.

THE PRESIDENT—We shall be glad to hear from Mr. Pearson, Jr.

MR. W. H. PEARSON, JR.—The mode of operating the process is as follows: Three tanks, at different elevations, are used for the purpose, so that the tar can run by gravity, from one into the other. The tar is first pumped into the upper tank, which

is open on the top, and is there heated by the introduction of live steam, by which means a portion of the water is removed by evaporation. The tar is then run into a second tank, which is entirely covered, but with an outlet pipe to the atmosphere. The tar is then further heated, by means of superheated air, and the water passes off through the outlet pipe, in the form of vapor. The tar is then run into a cooling tank, and is ready for barrelling. In the upper tank live steam is introduced through a pipe which runs to near the bottom of the tank. The air is introduced into the second tank at a pressure of about 30 pounds. It is first pumped into an accumulator, and is then passed through a furnace by which it is heated, and is forced from thence, directly into the tank. Most of the water is taken out in this way, and no trouble is experienced with it after that.

MR. A. S. MILLER—I think the paper of Mr. Douglas leaves the Association under the impression that most of the water gas tar has 50 per cent. of water in it. I have never made any personal analysis of this tar, but, in getting bids for it, I had occasion to send some to the distillers, and it is not to be supposed that distillers, in buying tar, would give any low percentage of water if they could help it. They reported that we had only 20 per cent. of water in the tar. They buy the tar from us, and pay us a price almost as great as coal tar is selling for in the immediate neighborhood. We can retail that, for any work for which coal tar is used, for just about the same price that coal tar is retailed at. There is not a difference of 50 cents per barrel.

MR. J. A. P. CRISFIELD—I would like to ask Mr. Pearson whether, in the process he describes, the steam comes in contact with the tar?

MR. W. H. PEARSON, JR.—The steam comes in contact with the tar right at the bottom of the tank. The tar is first prepared in the open tank, and then is run into the closed tank, where the superheated air is introduced.

MR. J. A. P. CRISFIELD—How are the second tanks heated?

MR. W. H. PEARSON, JR.—With hot air.

MR. J. A. P. CRISFIELD—How is the air heated?

MR. W. H. PEARSON, JR.—By pumping it through the furnace in a series of pipes running backward and forward.

MR. C. R. FAREN, JR.—I think the percentage of water contained in gas tar varies with the form of apparatus used. In the washer—or rather the scrubber—we have used, the arrangement is such that the water, falling a great distance, makes an emulsion with the tar, and the percentage of water contained is very high: 50 per cent. would not cover it. It would be nearer 66 per cent. I have prepared that tar for use as fuel in furnaces, and had to get rid of the water, and I very successfully accomplished it by resorting to the use of a still known as the "Yaryan" still, which consists of a boiler tube 2½ inches in diameter, encased in a 3-inch tube. The annular space between the two pipes is charged with steam by the ordinary boiler pressure, and a continuous stream of tar is let into the upper portion of this pipe, and flows through this still to the outlet. In passing through there all that portion of the tar consisting of water, and of other products that will volatilize at the temperature of steam, rises in vapor, and that portion of it which is not volatilized comes out as clear tar, with all the water eliminated. The still that we used has four lengths, of about 16 feet each, and they are connected together at the elbows so that they make about 65 or 70 feet of 2-inch pipe to travel through and give the water an opportunity to rise in the form of steam.

MR. A. E. FORSTALL—I would like to ask Mr. Douglas or Mr. Pearson how long it takes to get the water out of the tar by the Douglas process, or by the Toronto process.

MR. D. DOUGLAS—I would just point out that, after all, the whole subject is a question of manipulation. It is very evident that it requires more heat than 212°, but if you get the temperature up high enough the water will ultimately settle. As to the question of doing it cheaply and comfortably and well, Mr. Pearson's method was rather too expensive, too elaborate, for me to try in a place like Savannah, and would be rather too big a job. The other method, of doing it by steam jacket, I think is done at more cost, as it would naturally cost more money to get your heat applied to the tar by first putting fuel under a steam boiler. I was trying to do it in a simple way, and for a

moderate sized works. In this particular instance I merely took a shell, and put a fire under it, and in that little boiler there the whole thing is done. I do not have any elaborate arrangement, but it can be done in any form of apparatus, if you can get the temperature. With regard to the quantity of water in the tar, I may say that it will vary very much. If you use a large quantity of oil, and make a large quantity of oily tar, I have no doubt there will be less water than if you are making a thicker tar, and with thicker tar water will be harder to separate. All these things are matters of condition, and every different gas works, I have no doubt, would present a different condition.

MR. C. R. FABEN, JR.—I have to offer an excuse for my remarks. I was speaking at a disadvantage. I had not the pleasure of hearing the paper of Mr. Douglas read this morning; and as the discussion led to a method, I thought that I would describe the method which I used. I would like to ask Mr. Douglas about his process. Whether, on applying heat to a body of tar containing water, it does not foam a great deal.

MR. D. DOUGLAS—That is exactly the principle I used. The idea I had in doing this was that every little globule of water is encysted in tar, and when you apply heat that forms a bubble, and a mass of these bubbles is foam. I thought if I could only get these bubbles hot enough they would burst, the steam would come out, and the tar be separated. (Referring to the diagram.) I put the tar in this still; it is forced in by this pipe; we put tar in below *here*, and then wait until the pressure goes up to 25 pounds on the pressure gauge, when we open this cock, and then the still is full of foam. The foam comes up this pipe, is carried along here, and here, at the outlet I put a wire screen for the purpose of making the bubbles burst in passing through that screen. They then fall upon a plate here, and the tar drops into the tank, and then I find the whole thing separated. I expected that the whole of the tar would come over in the form of foam, but I find that a great deal of the tar is actually separated in this still itself, and a certain quantity of it is being drawn off *here* in the shape of heated water and tar. That is the whole process. It is adapted to small works which cannot afford to devote $1,000 or so for experiments.

Mr. W. R. Addicks—Is there any odor to those bubbles of air?

Mr. D. Douglas—Undoubtedly a little odor from the gaseous and lighter oils comes off; but you will understand that as I would have the whole thing boxed down, all of the vapors would be condensed, and would not annoy me at all.

Mr. A. E. Forstall—The object of my question was to see if there were no means of making any different arrangement with the water gas tar than with the coal gas tar, and whether it was entirely a question of expense. In Chicago they treated it in exactly the same way as coal tar. I want to see if there is any saving in fuel in these other methods, by putting steam through first, and then superheating afterward.

Mr. A. B. Slater, Jr—I have had some experience with water gas tar at Providence, and in the way we ran we had no water in our tar at all. We started, first, of course, with the tank full of tar—it is an underground storage tank—and then instead of running water into the seal we used a steam pump, pumped that tar into the seal, and kept our seal filled with tar. We found no appreciable variation in candle power by doing that, and all the condensation we had from the tar went off into the storage tank and accumulated there. No water came in contact with that tar. This was with a Lowe double superheater plant. Ordinarily the water goes into the scrubber and passes down through into the seal. We use no water at all with the scrubbers. We found that we got along just as well as we did when we used water, with one exception, which exception was that when the water went through the scrubber it acted virtually as a jet condenser to relieve the condenser of so much work, so that when we used no water there the condenser had more work to do in reducing the temperature. By that means we got our tar pure and clear without any water at all, and by no other process than the storage tar tank and the steam pump—that doing the whole business for us.

Mr. W. R. Addicks—Did you have any water in the scrubber?

Mr. A. B. Slater, Jr.—No water whatever.

Mr. W. R. Addicks—I am not using it there because I did not want any more water to contend with in separating the tar. I thought all along that the principal source of trouble with water in water gas tar is from the water in the hydraulic main. I think Mr. Slater hits the nail on the head in not using water in the seal. As far as the scrubber is concerned, the condensers will take care of themselves, and you will find very little water in water gas tar except that which is obtained principally from the hydraulic main.

Mr. A. B. Slater, Jr.—Another point I had in view in doing away with water in the scrubbers was to have the gas come in contact with no water whatever until after the gas has been reduced to the normal temperature — believing that a good deal of condensation of aqueous vapors in gas induces the formation of naphthaline. I had some trouble with naphthaline before beginning to run the tar that way, but since then have had no trouble from naphthaline in any place that I am aware of. In the wooden trays that we use in the scrubbers, and which have been running for a long time, with no water in there we found the wood to be practically in the same condition as railroad ties which have been creosoted.

Mr. W. H. Pearson—How many scrubbers have you?

Mr. A. B. Slater, Jr.—We have one scrubber on each set, and each set has a capacity of 20,000 feet per hour.

Mr. C. R. Faben, Jr—What do you use in the seal before the scrubber?

Mr. A. B. Slater, Jr.—I use tar for that. I have a small steam pump to pump from the under-ground storage tank.

Mr. C. R. Faben, Jr.—How long have you followed that practice, and what do you find to be deposited there?

Mr. A. B. Slater, Jr.—Since the first of last May, and I have had no deposit there at all, except in one case, where the man operating the plant allowed his heats to get too high, and formed some carbon, some of which came down into the seal from the stand pipe and there was a small collection of fixed carbon there, but not enough to amount to anything.

MR. C. R. FABEN, JR.—You draw the tar back from the scrubber?

MR. A. B. SLATER, JR.—That goes out in the drip by itself.

MR. W. H. PEARSON, JR.—Does Mr. Slater pump his tar through the scrubber into the wash-box?

MR. A. B. SLATER, JR.—The tar goes directly from the pump into the box, and nothing goes through the scrubber except the gas.

The thanks of the Association were voted to Mr. Douglas for his paper.

Mr. A. B. Slater, Jr., of Providence, R. I., then read his paper on the

INTENSITY OF LIGHT.

The title of this paper is slightly a misnomer owing to the peculiar and forced circumstances of its generation. The very unsaturated request of our Secretary pro tem. for a paper was heard and title given; but, then, in comparative vacuity of time it became necessary for the writer to clothe his ignorance in such words as might possibly disguise it, hoping that the thoughts herein suggested (none of them new or original) might draw out such discussion as would help some of us in making practical application of the principles sought.

You all understand the wave theory, which is the basis of nearly all present operations in light, that our commercial as well as the natural light is compounded of different colored lights of different wave lengths and corresponding frequency of vibrations.

The number of vibrations in a given time determines the color of the light, but the amplitude or scope of the vibrations determines the degree or intensity.

One prime object for the gas lighting engineer is to secure the production of the greatest amount of illumination for the money expended. The lights may be large or small, intense or weak, and of any desired color. These different properties may be independently changed in the same light, producing a range

in variety adaptable to all requirements, if it is correctly understood what the conditions of the case need.

There is no commercially produced light which is not concomitant with and practically dependent upon heat for its generation. In fact light and heat both follow the same, or so similar laws, as to be considered merely different manifestations of the same form of energy. The heat which brings about the incandescence may be mechanical, chemical or electrical. Mechanical as by friction, presumably as in the case of meteors, electrical, as we are all familiar with in the different electric lights, and chemical either directly by combustion of the incandescing body, or indirectly as when the incandescent body receives its heat from another source.

The ordinary observer knows that when a body is heated, it first begins to glow with a deep red which, as the temperature rises, passes up through vermillion, yellow, white, and finally to a bluish white. If we analyze this light in its different stages, we find that the various changes are very interesting and a knowledge of them valuable for practical application. We find that the light, at first a dark red, gradually adds to itself the colors of the continuous spectrum in their regular order, from the least to the most refrangible, from the red with its long wave length to the violet, with its minute wave length, and 800,000,000,000,000 of vibrations per second.

Nearly all solids on incandescing follow this same order whether their heat is derived from their own combustion or from some other source—the same degree of heat yielding the same extent of color, so that the temperature of an incandescent solid may be determined if within certain limits (from 1,000° to 2,200° F.) by spectrum analysis of the light emitted. Incandescence begins at about 980°, but is first perceived ordinarily at about 1,000°.

We know that the range of sensibility of the ear to sound is very limited, many sounds which we know to occur being beyond the capability of the ear to perceive, and also a sound of constant pitch may be so soft as to be imperceptible, or it may be so intense as to be painful, and intense, high sounds are the most painful and dangerous. We have the parallel of this in light, for our visible light or color disappears in darkness be-

yond the violet, and our eyes show us nothing below the red although we know the rays are there. And, too, we may have a color so faint as to be invisible or so intense as to be very painful, the more so as it approaches the high or violet end of the spectrum. There is no doubt of the effect on the eye, of a powerful naked arc light in which the violet and blue rays assert their predominance.

In the analysis of light, as before referred to, it is also found by special comparison that not only are the different colors added by the rising temperature, beginning with the red at about 1,000°, and finally reaching the violet at about 2,100°, but that their intensity increases after their appearance, and that, too, much more rapidly than the temperature. Platinum, for instance, yielding, at 2,600°, almost 40 times as much light as at 1,900°; and we note also that the increase of effect produced on the eye by the rise in intensity of the various colors is much greater in the case of the more refrangible rays than in that of the less refrangible red rays. Thus a gas light at 2,200° emits all of the colors given by the arc light at 8,700°, but the latter has the rays toward the violet end of the spectrum much more intensified than the lower rays toward the red; the difference in intensity of the two lights being due to the difference of 6,500° temperature.

With different colors of comparatively equal intensity the yellow is most visible; hence it is that, with two lights of equal size and density, the eye will pronounce in favor of a yellowish in preference to a bluish light for illumination. But what is illumination? Let us examine an ordinary gas flame first and work to a definition.

For combustion we take air for its oxygen, and will first mix it to excess with the gas, which we find will not then burn. But we will reduce the amount of air and after reaching a point at which combustion can take place, we very soon arrive at a saturated or explosive mixture. At this point combustion is instantaneous and no light is emitted, this being the form of combustion used in gas engines. Passing this point in reducing the amount of air mixed with the gas, it becomes necessary for complete combustion to give air at the point of ignition, and we arrive at the conditions of the Bunsen burner, but still get but

little light, and that due mostly to the carbonic oxide. If we now use the Bunsen burner and gradually cut off the air supply at the base, we notice this: that when the air supply is too great, or what is equivalent, the gas supply is too small, the flame will, as we say, retreat, as the mixture approaches the explosive proportion, and in most cases will then have insufficient air supply causing incomplete combustion; one noticeable result of which is the liberating of hydrogen from the marsh gas, forming acetylene, which, escaping unburned, is readily detected by its odor. Still reducing the air supply, a dark cone rises in the center, the surface of this cone showing us where the mixed air and gas arrive at the degree of ignition. This cone will rise gradually, at the same time losing its sharp definition and finally becomes undiscernible.

Under the conditions of combustion so far, our gas, if good, containing only hydrogen, carbon and oxygen, has yielded us no light, because the hydrogen and carbonic oxide in burning are practically non-luminous, and the gas has had the air so mixed with it that the carbon was oxidized as it became nascent without being brought to incandescence. Proceeding with the experiment, the air mixed becomes insufficient for complete combustion and the oxygen, having greatest affinity for hydrogen, collects it from the various gases in the mixture, but is insufficient then to oxydize all the remaining carbon, some of which thus set free is made incandescent by the heat as the current takes it up to where it finds oxygen to combine with.

The flame draws air in upon itself and its outer surface shows the same effect as the inner part, but with the addition that the supply of oxygen is greater and by its diffusion the flame finally supplies to the inner part, as it rises, the necessary oxygen to complete combustion. If we take a horizontal section of this flame, we will have a ring of light which will show yellow, in the middle of its width, but the colors to the inner and outer edges both run to the violet end of the spectrum, showing not a trace of the red and orange; these colors giving a direct index of the temperature at the different points on the diameter of the flame. Still reducing the air supply, the yellow in the section gradually broadens on its inner edge and shows a gradual transition to the red end of the spectrum, which is reached when the air opening is entirely closed.

The gas now depends entirely on the air surrounding and diffusing into the flame. The hydrogen and carbonic oxide oxydize directly, furnishing heat to decompose the hydrocarbons in proportion to their carbon, most of which, set free, rises in the flame becoming incandescent, and if the diffusion of air into the flame be insufficient, due perhaps to low pressure on the gas at point of issuing from the burner, the carbon will agglomerate and, its temperature falling below the point of ignition of solid carbon, it passes off as smoke, perhaps being deposited as lampblack. In fact a very large percentage of the carbon in the gas may thus be deposited by giving insufficient air and also chilling the flame.

If now we increase the pressure of the gas, its increased velocity on issuing from the burner causes it, like any jet, to draw in upon itself the surrounding medium, and the result is an excess of air, first mixing into the flame, making complete combustion with part of the gases and breaking up a portion, combining with some resultants and setting free others which escape and the gas is not all burned. Carrying this still farther, the excess of air exerts such a cooling action that the flame will finally in actual fact blow itself out.

Now let us return to the conditions of good combustion for luminosity, using a flat-flame burner to get a flame of larger area. Now we can see that the *intensity* of the light depends upon the degree of incandescence of the minute particles of free carbon rising in the flame, and that is governed by the heat generated, less that absorbed by diluents and excess of air, and also, in case of a bad burner, by the burner itself. The intensity then being in direct ratio to the temperature.

The *density* of the light is equal to the intensity of the light multiplied by the amount of surface of luminous carbon per unit of area; and the *quantity* of light from any source is equal to the density multiplied by the area of the luminous source as a whole. Hence, we see that we may have two lights of the same size and intensity, but of different density and consequent illuminating power; the density being the measure of the quantity and the intensity the measure of quality of the light emitted. This can be proved on the bar photometer by varying the composition of the gas tested. Now we may say that the *illumina-*

tion of an object is the amount of light received by it, less that absorbed and directly transmitted.

From the foregoing we see that the richer the gas the smaller the burner orifice must of course be, or the pressure greater, thereby drawing in the necessary increase of oxygen, which, within limits, will intensify and thus reduce the space of combustion and so make the light more dense and intense. The luminous flame grows comparatively less in area. Increased pressure will not cause the amount of air drawn in to increase in the same proportion as the amount of gas increases, the amount of gas issuing being directly as the square root of the pressure and inversely as the square root of its gravity.

Considering the definition of density of light, we find the reason that, in testing gases of different candle power with a flat-flame burner, the light from the poorer gases suffers less by taking the flame edgeways than that from the richer gases.

Sugg said (if I quote him correctly) that "with like burners, equal-sized flames are of the same candle power," and hence originated Sugg's Illuminating Power Meter. But, laying aside the question of gravity, have we not found that by varying the composition of the gas we may vary the density of the light from the same size flame and thereby its candle power? So that if Sugg's meter is to be commercially correct, the composition of the gas must be kept within certain lines; that is, it will do for only the particular kind of gas for which it is adjusted.

In photometry instead of saying that the *intensity* of the light is inversely as the square of the distance, we may say that the *quantity* of light is in that ratio; for we admit that the quantity of light from two candles is greater than that from one, but is there really any greater intensity?

There are really only two photometers that are commercially practical for testing gases of various kinds—that of Bouguer, derived from Count Rumford's (the only one in which lights of various intensities of distinct colors may be accurately compared,) and the bar photometer in its many forms and with its various accessories as the refrigerator, air oven, reducing lens, etc. With any photometer we must have a standard of light and we find quite a list of candidates, beginning with the candle, which, when properly made, still stands to the front for

practical use, the Carcel, Keates and Pentane Lamps, the Platinum Strip and various other ingenious devices, coming finally to the Methven Slit.

Most of these require more time and care in their use than their advantages are worth. The Methven Slit, however, is a very clever and practical device; for, as the same size of slit is used for gases varying within wide limits, we find that within those limits the gravity and composition of the gas, as regards heating components, will not vary very materially, hence the intensity of the light is within narrow bounds, and as the burner used for it is an argand, it virtually presents to the slit one flame behind another, thus maintaining the effect of one flame of practically uniform density of light, so that the quantity of light which passes the slit is very constant when used with gas which is within the limits for which it is adjusted. One very great advantage of this form of standard is that, the same gas being used at both ends of the bar, the colors of the lights will be about the same except only with the extreme variations in the burners.

It is obvious that no one burner will give fair results in testing the candle power of all commercial illuminating gases. The chemical composition and specific gravity must both be respected; and knowing these, burners can be constructed, simple and cheap, to suit the requirements of any particular case.

Our photometers measure not simply the intensity, but the quantity of light from a given source, and although we may have the same quantity of light from a small source of high intensity as from a large source of low intensity, the illumination from them will be of totally different character. Extreme variations in the distribution of light on the retina strain and injure the eye. Everybody knows the effect of looking at a bright spot on comparatively dark ground, or a very dark spot on a bright ground. The effect is very much lessened if there be no sharp outlines, for then the contrast is reduced, and it is found that for this reason the penumbra afforded by large lights count much in their favor.

This brings us to the diffusion of light, which is simply direct light reflected, refracted and diffracted, suffering partial separation and recomposition, thus being toned by the color of the

objects by which the diffusion is accomplished. While penumbra are produced by the difference in angle of direct light from different parts of the same source, diffused light is not limited to such definite angle, and, therefore, blends the shadow, often to a mere shade. The diffusion of the light will be greater as the source is larger, depending also upon the density of the light, and in proportion as it contains the more refrangible colors.

It has been stated that white light would not diffuse as well as yellow light, but as white light has all the components of the yellow light there can be no greater diffusion by the latter, except that it be greater in quantity, noting also that yellow is the color which, of all the colors, taking them singly, produces the greatest sense of illumination in the eye.

Heretofore, among gas makers it has been considered that the question of illumination was a very complex one, that intensity and candle power were the same thing, and that color was entirely independent of intensity, while density of light, although barely noticed simply as a rich or thin light, has not been recognized. In gas lighting, the light being emitted by individual particles of carbon, the density of the light must be considered as distinguished from intensity.

By this we see why compounding argands, as in the six-ring Douglas lighthouse burner, the efficiency of poor gases is enhanced so much more rapidly than that of rich gases: for the poorer the gas the fewer incandescing particles of carbon per unit of area, thus leaving space for the inner flame to send its light through, and add to that of the outer flame. With a rich gas there will be less opening through the outer flame, and the light of the inner flame would be proportionately obstructed, while both gases receive the benefit of the concentration of heat.

With incandescing burners many of the conditions are inverted, for now the gas is burned only for the greatest amount of heat that can be derived from it, and we find a new subject for investigation. I have already stated that nearly all solids follow the same order in emitting light when heated. But many solids do not, some becoming luminous in a ratio far differing from that observed in elementary solids, and notably among the

metallic oxides, whose qualities have been described by Mackean, while the subject of super-incandescence, or luminescence, is thrown open by the paper of Mr. Nichols to the New York Electric Club.

Discussion.

THE PRESIDENT—You have heard an interesting and instructive paper on a topic of interest to us all. I trust you have given it a careful listening, and are prepared to discuss it, or at least to question the writer for the reasons of his views.

MR. C. R. COLLINS—Did I understand Mr. Slater to say that the only luminosity was due to the carbonic oxide?

MR. A. B. SLATER, JR.—Under the conditions of combustion which I was then describing the only illumination shown at that point would be due mostly to carbonic oxide. There might be a trifle due to the methane, but I think not much, if any.

MR. J. A. P. CRISFIELD—I would like to ask Mr. Slater what is the best kind of burner for 28 candle power water gas?

MR. A. B. SLATER, JR.—There could be quite a variety of burners constructed which would be very good for it. It would be hard to determine that without experiment. I should think that a burner which would give a very thin flame, and that would give full scope to the heating components would be the best.

MR. J. A. P. CRISFIELD—Is the argand burner a good burner for water gas?

MR. A. B. SLATER, JR.—It depends entirely upon the construction, I think. I should not consider it as good as a thin flame—a flat-flame burner. In fact I have found by my own experiments that the same gas, (high candle power water gas) has given better candle power in the bar photometer with a thin flame, flat-flame burner, than I got with the ordinary D-argand.

MR. A. E. BOARDMAN—I have listened very attentively, and with very great pleasure to this paper, and to the others this morning which throw light on the intensity of flame, flame tem-

peratures, and the effect of temperature of incandescent carbon on flame, with regard to luminosity. I am glad to see that Mr. Slater's paper points toward the position which I think I have always maintained—that large flame areas, even if of a little less intensity were better for general illumination in increasing the penumbra of the direct light, and increasing the ability of the reflected light to produce the sensation of light upon the human eye. I think that this explains in a manner the reason why, although the mixture of water gas and coal gas in the direct experiment, by photometric examinations and by the theoretical calculation of flame temperatures, etc., does not indicate that it gives or would give a higher illuminating power; still to the eye it does. It increases the flame area of the water gas, and increases the flame temperature of the coal gas, giving us a whiter and larger flame than we could get from either by itself. I think that the slight tinge of yellow imparted by coal gas is an advantage, in that it produces on the eye the effect of greater luminosity. In his introduction to the paper Mr. Slater touches upon the very beautiful comparison of light and sound; and it may be of interest to some of you who have not studied the matter to know that there is a very great similarity, and that, while the figures do not correspond exactly, we understand that sound covers a certain number of octaves, and that a certain part of sound belongs to a certain number of vibrations in music, and that we can go up through a series of vibrations until we come to light. It is a curious coincidence, if it is a coincidence, that the numbers of vibrations in different colored rays in the spectrum correspond very closely to multiples of the different musical notes in octaves of music; the musical octaves extending from 16 vibrations to the second, up to 32,000. Then the high vibrations of light, which are invisible, and extending through about 22 octaves, until we come to a lower amount of light and go through the spectrum from red to violet. I mention that as a matter of interest, and as a beautiful study—the relationship between light and sound.

Before taking my seat I wish to move a very hearty vote of thanks to Mr. Slater for his very interesting and valuable paper.

MR. F. EGNER—I second the motion.

Mr. A. G. Glasgow—I would like to observe that we should be a little careful in drawing our analogies between sound and light. Sound is produced by vibrations, it is true, but by the vibration of air. For instance, you may strike a gong inside an air-tight vessel and hear it perfectly well; but when you pump the air from within this vessel you cannot hear it at all; such vibrations as exist there are those of light and heat, which are transmitted, it is supposed, by vibrations of an ethereal medium that pervades all space. Concerning intensity,—the intensity of light, as we understand it, or as I understand it, is measured by the impression which it produces upon the eye, and is not at all measured by illumination. For instance, we may look at an incandescent light, and it will give to the eye an impression of highest intensity, but if you want to find out the practical value of the light as an illuminant, you should turn your back to it, and see what you can see; and it is in this instance that the matter of color comes up. A flame may emit exclusively yellow rays, and as Mr. Slater observes may, per unit of light, produce the maximum effect of illumination upon the eye; but that same yellow flame, when you are not looking at it, but are looking at other objects illuminated by it, only shows up those particular objects that reflect yellow rays. If your room is filled with yellow objects, then of course yellow light has the greater advantage, but in an ordinary room filled with variegated colors, it seems to me that the light that we want is a white light containing *all* the rays, yellow as well as the others, that will reflect back whatever colors the surrounding objects happen to possess. The color of an object is indicated by the ability of that object to reflect certain rays of light and absorb others; and so to show all colors advantageously, you want a source of light which emits all the rays. You do not want it to emit only yellow rays, because your eye is more sensitive to yellow light, unless everything around you is yellow. Then you want all the rays yellow.

Mr. J. A. P. Crisfield—I would like to ask you if you believe that it would increase the amount of light in a room by surrounding it with mirrors?

Mr. A. G. Glasgow—I do. Certain articles have the power

of absorbing light, but I do not think that a mirror possesses that characteristic. By the use of mirrors you certainly increase the illumination in a room, although you may not be said to increase the light—for that depends upon what you mean by "light." A great many objects in a room may absorb certain rays of light; now, if you replace those objects by mirrors, you thereby increase the illumination of the room.

MR. A. B. SLATER, JR.—With regard to the best burner for high candle power water gas, I think it will be found, as I have found in all my experience, that the gravity of the gas must be respected as much as its candle power; and that the greater the gravity the greater proportionately must be the pressure used; and that with an increase in the illuminants the size of the opening of the burner would naturally be reduced. I think that you will find, as I did, that some of the old-fashioned Argand burners, which, with low candle power coal gas give an efficiency of about 30 per cent., with high power water gas will give a very high efficiency, because the thinner the flame the more effect you get from the illuminants that are being consumed, because none of them will be lost by being consumed in the center, and whose emitted light would be obstructed by particles in the outer part of the flame. Therefore, a thinner flame will give greater efficiency for the gas. In regard to the effect of light on the eye, I think that we can refer back to the paper read by Mr. Jones before this Association at the former New York meeting. He there referred to the effect of different lights upon the eye, and to the sense of illumination, and stated that the sense of illumination upon the eye increased only in a very small ratio in comparison with the increase in the intensity of the light. With reference to the point of the illumination of a room, I think you may take as the definition of the illumination of an object, that it is the amount of light received by it, less that which is absorbed and directly transmitted through it; and that when you ascertain the amount of light which is reflected to the eye you are getting at the real illumination. For instance, if we have a slightly yellow flame and throw it upon an object which is Prussian blue, you will get almost no illumination at all, because the light would be almost

entirely absorbed. But if you have a blue object and illuminate it with a blue flame, then you will get the maximum of illumination for that color; or if you have a yellow object you will get the maximum illumination from a yellow flame. For instance, the furniture in this room is illuminated by a flame which is slightly yellow, and it appears very light when compared with the colors of the columns and of the general trimming of the room. They reflect less light and absorb more.

The thanks of the Association were voted to Mr. Slater for his paper.

The President introduced Mr. Rollin Norris, of Philadelphia, Pa., who read the following paper on the

THEORETICAL EFFECT OF PRE-HEATING BLAST STEAM AND OIL IN WATER GAS MANUFACTURE.

The sharp competition of the electric light and of kerosene oil, and public sentiment, backed and emphasized by the, apparently, almost omnipotent, but alas! far from omniscient "city father," unite to demand that we supply our consumers with gas at the lowest possible price. Even without these spurs to effort, a broad spirit of commercial morality would urge us to reduce to the utmost our waste of manufacture.

An intelligent observer watching, with this idea in his mind, the operation of an ordinary water gas plant, cannot but be struck by the great quantity of energy that leaves the apparatus in the form of sensible heat, both of the blast products and of the illuminating gas.

It is to a consideration of these losses that your attention is invited, as well as to the possibility of reducing such losses by making the hot outgoing gases impart their heat to the incoming elements of manufacture.

Although the figures in this paper will be based on the performance of an apparatus of the Lowe type, many of them will apply with equal, and in some cases with even greater force, to the other types of machine.

In these calculations use will be made of the experimental data, given by Mr. A. G. Glasgow in his paper read before this

Association last year, and entitled, "The Commercial Efficiency of a Water Gas Apparatus."

The data used are as follows:

Table I.

	Per 1,000.
Total anthracite charged	33.4 lbs.
Ash and unconsumed coal recovered	9.9 "
Total carbon consumed	23.5 lbs.

Table II.—Carbureted Gas.

	Composition by Volume.	Weight per 1,000.	Heat Units per 1,000, per Degree.
CO_2 and H_2S	3.8	4.65842	1.008082
$C_n H_{2n}$	14.6	17.09952	6.316563
CO	28.0	21.86800	5.421077
CH_4	17.0	7.58540	4.497384
H	35.6	1.99146	6.780125
N	1.0	0.78596	0.190684
	100.0	53.98876	24.213915

Table III.—Uncarbureted Gas.

	Composition by Volume.	Volume per 1,000 of Carbureted Gas.
CO_2	3.5	23
CO	43.4	280
H.	51.8	334
N.	1.3	8
	100.0	645

Table IV.—Superheater Blast Products.

	Composition by Volume.	Composition by Weight.	Specific Heat.	Weight per 1,000 Cubic Feet.
CO_2	17.4	24.64	0.05342	21.331
O	3.2	3.29	0.00718	2.856
N	79.4	72.07	0.17585	62.405
	100.0	100.00	0.23645	86.592

Table V.—Temperatures.

Illuminating gas leaving superheater........ ...	1,450° F.
Blast products.....	1,550° F.
Oil entering carbureter......................	235° F.

Table VI.—Miscellaneous.

	Per 1,000.	
Heat lost by radiation and convection.......	28,150	heat units.
Heat lost as sensible heat of ash and cinder..	3,712	"
Latent heat of gasification of the oil	12,841	"
Heat absorbed in the decomposition of steam.	90,533	"
Air required........	2,457	cubic feet.
Oil used = 5 gals. = ...	35	lbs.
Percentage of straight water gas in carbureted product..	64.5	per cent.
Carbon used in blasting..	13.9	lbs.
Carbon taken up by the steam..	9.6	"

The elements used in the course of the manufacture of water gas are, coal, steam, oil, and air, and, as it seems impracticable to preheat the coal, my subject divides itself into the three heads of: (a), steam; (b), oil; and (c), blast.

(a.) *Steam.*

As the steam and oil are used while the illuminating gas is making, we will calculate their capacity for absorbing the heat then being wasted as well as the amount of such waste.

Amount of Heat Carried by Escaping Carbureted Gas.

Table II. shows that each 1,000 carries some 24.214 heat units per degree of temperature, and as the temperature of escape is 1,450° F, the total sensible heat per 1,000 is 35,110 heat units.

24.214 (heat units per degree) × 1,450° = 35,110 heat units.

This is equal to about 2½ lbs. of carbon per 1,000.

Steam Used Per 1,000.

Table III. shows that each 1,000 contains 334 feet of hydrogen, which has been derived from the steam decomposed.

This hydrogen required for its production 15.89 lbs. of steam, or, in round numbers, 16 lbs. of steam per 1,000.

334 feet H. ÷ 189.2 feet per lb. = 1.7653 lbs. of H.

As water contains one-ninth its weight of H., the 1.7653 lbs. of H. must have required 1.7653 × 9 = 15.8877 lbs. steam.

The amount of heat that this steam is capable of absorbing and carrying back to the apparatus, is 7.6 heat units per degree of rise of temperature.

Sixteen (lbs. steam) × 0.475 (specific heat of steam) = 7.6 (heat units per degree of rise.)

The gases leave the stack at 1,450°, so this is the limit of attainable temperature of the steam. At this temperature, the steam would have absorbed some 8,500 heat units.

1,450° (final temperature)—330° (initial temperature) = 1,120° (rise in temperature), × 7.6 (heat units per degree) = 8,500 heat units.

That is, with the steam raised to the very highest possible temperature, the total direct saving to be anticipated would be only a little over half a pound of coal per 1,000; and with the steam raised to, say 800°, which is probably as much as we could practically count on, the saving would only amount to about ¼ pound of coal per 1,000.

The direct economy, therefore, of suberheating our steam by the sensible heat of the outgoing illuminating gases is too small to warrant our going to much trouble to effect it, but the incidental results of such superheating may be more important.

Among these incidental advantages may be mentioned the thorough drying of the steam and the gasification of the entrained water, thus reducing the work required of the bottom of the fire. Moreover, the higher the temperature of the steam the nearer it is to the point of decomposition, and the less time it has to be exposed to the action of the fire. This means an increase in the capacity of the set, which in itself introduces some additional economies.

With very highly superheated steam, probably some trouble might be expected from clinker, but in my own experience, with steam heated to about 800° Fahr., practically no more trouble was met with from this cause than in a corresponding set run with saturated steam.

(b.) *Oil.*

As our steam promises to save but a small part of our waste heat, we must turn to the oil for assistance. Of the importance and advantage of preheating this element it is scarcely necessary to speak. With the use of crude and intermediate oils, some sort of preheating is almost a necessity, especially if the oil be fed directly upon the fire.

The capacity of 5 gallons of crude oil for absorbing heat is 15.2 heat units per degree.

35 (lbs. of oil) $\times 0.434$ (specific heat as per Regnault) $= 15.19$ heat units required per degree rise in temperature.

A heater raising the oil 500° in temperature would absorb 7,600 heat units.

$$15.2 \text{ heat units per }^\circ \times 500^\circ = 7{,}600 \text{ heat units.}$$

This is only equal to a little over ½lb. of coal, but sight must not be lost of the fact that the oil contains a large proportion of constituents that, at moderate pressure, would vaporize below 500°, and so the absorption of heat would be much greater than the 7,600 heat units, as figured above. It is evident, then, that the lower the pressure of the oil in the heater, the greater will be its capacity for heat absorption, and the practical lesson is that our oil heaters should be operated under only as much pressure as is required to scatter the oil over the fire, or the carbureter bricks.

(c.) *Blast.*

We have seen that the amount of heat that can be recovered by preheating the steam and oil is necessarily small, but we come now to a more promising element—the blast.

As the air is entering the set while the hot blast products are leaving it, it is these latter that we will use as a source of heat for the blast.

Heat Carried by Blast Products.

The total heat thus wasted at an exit temperature of 1,550° is 78,000 heat units, or about 5½ lbs. of carbon.

The volume of blast products equals the volume of air used, or 2,457 cubic feet per 1,000.

.086,592 (weight per foot) × 2,457 feet × 0.23,645 (specific heat) × 1,550° temperature = 77,976 heat units per 1,000 carried by blast products at 1,550°. This is 50.3 heat units per degree, or 3.62 heat units per degree per lb. of carbon carried.

We will assume that preheating the blast will make no change in exit temperatures of the illuminating gas or of blast products in heat lost by radiation, convection, and cinder, or in heat absorbed in the decomposition of the steam.

The actual heat required in the set per 1,000 is, therefore, 174,000 heat units.

Heat absorbed in decomposition of steam…	.90,533	heat	units.
Sensible heat of escaping illuminating gas..	.35,110	"	"
Loss by radiation and convection...........	.28,150	"	"
Latent heat of gasification of oil	12,841	"	"
Sensible heat of oil at 235° = 35 lbs. × .434 specific heat × 235° = ...	3,570	"	"
Sensible heat of ash and cinder withdrawn..	3,712	"	"
Total heat required in machine, per 1,000 =	173,916	"	"

This heat is supplied partly by the combustion to CO and CO_2 of the carbon taken up from the fire in the decomposition of the steam, and partly by heat stored in the set during the blow.

The first is readily calculated, and equals 48,000 heat units developed in fire during the run.

Each 1,000 of the carbureted gas contains 23 feet of CO_2 and 280 feet of CO, which carry 9.6 lbs. of carbon.

23 (feet of CO_2) ÷ 8.623 (feet per lb.) = 2.667 lbs. of CO_2.

280 (feet of CO) ÷ 13.531 (feet per lb.) = 20.694 lbs. of CO.

2.667 (lbs. CO_2) × $\frac{12}{44}$ (proportion of carbon in CO_2) = 0.73 lbs. C.

20.694 (lbs. CO) × $\frac{12}{28}$ (proportion of carbon in CO) = 8.87 " "

Total carbon per 1,000 .... 9.60 " "

Total potential energy of the C=9.6 lbs.
C$\times$14,500 heat units per lb.=....... 139,200 heat units.
Potential energy of the CO produced=
20,694 lbs. CO$\times$4,395.6 heat units
per lb.=......................... 90,962 " "

Net energy developed in this partial
combustion=................ 48,238 " "

The heat to be stored in the set, therefore, equals the total heat required less the heat supplied by this partial combustion; or 126,000 heat units.

Total heat required per 1,000=......... 173,916 heat units.
Heat from C taken up during run=..... 48,238 " "

Net heat to be supplied during blasting=125,678 " "

The heat stored in the set per lb. of carbon burned, equals total heat per lb. of carbon, plus the heat carried by the air for combustion, less the heat discharged at the superheater stack, per lb. of carbon burned.

The potential heat of a lb. of carbon is 14,500 heat units.

The air used for burning one lb. of C has a heat carrying capacity of 3.22 heat units per degree.

Table VI. shows that for 13.9 lbs. of C, 2,457 feet of air were used. So air required per lb. of C equals

2,457 (feet per 1,000)$\div$13.9 (lbs. C per 1,000)=176.8 (cubic feet air), 176.8 (cubic feet air)$\times$0.0767 (lbs. per foot)$\times$0.2377 (specific heat)=3.22 heat units.

The heat leaving the stack per lb. of carbon is 5,453 heat units.

Table IV. shows that each lb. of blast products contains 0.2464 lbs. of CO_2; 0.2464 (lbs. CO_2)$\times\frac{12}{44}$ (carbon factor for CO_2) =0.0672 lbs. C per lb. of products. One lb. of C therefore gives 1$\div$0.0672, or 14.88 lbs. of products.

14.88 (lbs. products) $\times$ 0.23645 (specific heat) $\times$ 1,550° = 5,453 heat units.

A convenient way of expressing the saving to be expected will be by means of a formula.

Let t = the rise of temperature of blast. Then 3.22 t =

heat units carried into the set by the air per pound of C., and $14,500 + 3.22\,t$ = total heat carried into set per lb. of carbon consumed.

The heat discharged at the superheater stack valve we have shown to be 5,453 heat units. Therefore the heat utilized in apparatus is $(14,500 + 3.22\,t) - 5,453$, or $9,057 + 3.22\,t$ = heat units per pound of C consumed in the blow.

As the total net heat required per 1,000 is 125,700 heat units, the carbon that must be so consumed, in the blasting is $\frac{125,700}{9,057 + 3.22\,t}$ lbs. C consumed in blast at temperature t°.

The saving in coal per 1,000, due to pre-heating the blast t° by the heat of the outgoing blast products, is $\frac{214 + 49.73\,t}{9,057 + 3.22\,t}$ = coal saved per 1,000 for blast at t°. 13.9 (lbs. C with cold blast) $- \frac{125,700}{9,057 + 3.22\,t}$ (lbs. C with hot blast) $= \frac{192.3 + 44.758\,t}{9,057 + 3.22\,t}$ = saving in C per 1,000.

Dividing this by $\frac{9}{10}$ to reduce C to coal gives, after reducing, $\frac{214 + 49.73\,t}{9,057 + 3.22\,t}$ = saving in coal per 1,000 for t°.

For example, the coal to be saved by raising the temperature of the blast 500°, 1,000° and 1,500°, will be 2.35 lbs., 4.07 lbs. and 5.39 lbs., respectively.

The last figure, 5.39, would be unattainable in practice, as it would involve the use of a heater so perfect as to deliver the air at the temperature of the blast products as they leave the stack.

The reduction in temperature of the blast products, due to raising the air t°, would be $\frac{3.22}{3.62}\,t$, or, roughly, $\frac{8}{9}\,t^\circ$.

It must be remembered that these figures are based on the very low consumption of 23.4 lbs. of combustible per 1,000. As the amount of coal burned per 1,000 increases, the margin of possible saving due the use of hot blast increases.

I have up to this point considered only the direct saving due to the heat actually returned to the system by the heated air; but there is another advantage, which should in many cases

effect a considerable economy. I refer to the resulting absence of condensation of steam in the lower part of the fire, and subsequent loss of heat in its re-evaporation.

The grate bars and ash at the bottom of the fire will necessarily reach a temperature at least as high as that of the blast, and this will be far above the condensing point of the steam. Thus the tendency will be to keep the fire well down on the grate bars, and promote a more complete combustion of the coal at the bottom of the fire. This means less cinder, less frequent cleaning of the fires, and consequently smaller loss of fuel in pieces too small to be recovered by screening.

Ordinarily, more CO is made in blasting than is needed to keep up the temperature of the fixing vessels, and this surplus is discharged unburned through the stack valve. A hot blast means a smaller consumption of coal, and consequently a smaller production of CO and a reduction in CO wasted.

The possible disadvantages of blast heating are the danger of over-heating the grate bars, and the effect on the clinker formation. The former is a matter of construction detail, and I believe the clinker problem can also be handled.

Summary.

Steam.—We have seen that the steam has a very small heat carrying capacity, and that its preheating will not pay unless the means employed be very simple.

The maximum direct saving to be expected is from $\frac{1}{4}$ to $\frac{1}{2}$ lb. of coal.

Oil.—The capacity of the oil for absorbing heat is also small, but it must be preheated for economical candle power results, and the illuminating gases are a convenient source of heat for this purpose, and they give as high a temperature as the oil can well stand. Moreover, the vaporization of the oil in the heater makes its heat absorbing power greater than at first sight appears.

Blast.—The advantages of preheating the blast are:

1. A saving of from 2 to 8 lbs. of coal per 1,000, due to the heat actually returned to the apparatus by the hot air. 2. A saving of the heat usually lost in re-evaporating and decompos-

ing the steam condensed out in the lower part of the fire during the run. 3. More complete combustion of the coal, and a smaller formation of cinder, involving less frequent cleaning of fires. 4. Less time required for blowing up the heats and a consequent increase in daily capacity of set. 5. Reduced waste of CO. The margin for fuel saving in water gas manufacture is no longer very large, but it seems that an efficient blast heater is the most promising factor in the problem.

Discussion.

THE PRESIDENT—The paper is before you for discussion, and Mr. Norris will be very glad to explain the subject further if any member desires to ask any questions.

MR. W. H. PEARSON—I would like to ask Mr. Norris whether he has any satisfactory and workable method for preheating oil?

MR. R. NORRIS—I can very highly recommend what Mr. Pearson has.

MR. W. H. PEARSON—But Mr. Pearson has not got any at the present time, because it would not work. I can describe the method which Mr. Pearson had, unless you choose to do it yourself—perhaps you had better do it—and then I would like to ask a few questions afterwards. Certainly, that method did not work well in Canada; I do not know how it works over here.

MR. R. NORRIS—It is a series of pipes in the take-off pipe, into which oil is admitted at the bottom, and then goes up against the current of the gases.

MR. W. H. PEARSON—I am sorry to say that in our case the pipe very soon filled up with carbon. This was not under our own manipulation, but under that of a representative of the builders; consequently that failure cannot be attributed to any fault on our own part. Moreover, the pipe on several occasions, gave so much trouble, that the representative of the contractors took it out, and we found that we can do quite as well without it as with it.

MR. C. R. COLLINS—In the question of preheating oil at

Toronto, you must take into consideration the oil which was used. It is a native oil, of much higher gravity than the Lima crude which we use in this country. We found there that we had an excess of heat, and necessarily lost a great deal of our waste product; and we found that this light oil could be vaporized readily without the use of the preheater. The preheater was continued in use for about 30 days, when it was definitely demonstrated that there was no economy effected, and that, necessarily, lampblack would collect from the lighter oil. I cannot say that the preheater is inefficient, but I simply say that in that case we had more heat than we could dispose of, and it was an unnecessary part of the apparatus.

Mr. W. H. Pearson—I am very much pleased to hear Mr. Collins admit that the Canadian oil is so much superior to Lima oil.

Mr. C. R. Collins—I do not think there is any question about that. We had no trouble in obtaining excellent results.

Mr. A. C. Humphreys—I would like to say a word in explanation of what we have got to look at in designing water gas apparatus. Mr. Pearson takes what Mr. Collins says as an acknowledgement that the Canadian oil is better than Lima crude; but it is not, and for this reason. Naphtha would not constitute a proper oil to use with that preheater—it never was designed for it, and it would surely make lampblack. Because of that fact—that naphtha cannot be used with that preheater—we do not say that naphtha is a better gas making material than Lima crude oil.

Mr. W. H. Pearson—I always thought it was.

Mr. R. Norris—I would like to ask of those who have had experience in the use of the hot-blast with superheated steam, whether the effect that can properly be expected is realized.

The President—Has any gentleman had experience in using the hot-blast in connection with a water gas apparatus?

Mr. F. H. Shelton—I had a little experience some time ago, and, although the results were not very definite, they pointed in that direction, and showed us that, working in that direction, we can get better results on top of the good results

we are already getting. I refer to two small water gas sets that were under my charge 4 or 5 years ago. One was fitted with a blast heater and oil preheater, but had no device for steam superheating. It may be that that was added later. I know that another set, alongside of it, had none of these appurtenances. Upon cleaning the fires after a full day's run we were very much gratified to notice how bright and how good the fire was which had the use of this superheating attachment. We could find red coals clear down to the grate. The tax upon the bars was by no means so great where the preheated blast was used. That particular plant has since fallen into disuse from the fact that that work was experimental, and the attachments have dropped to pieces. The blast pipe at that time was made with soldered joints, and the air was preheated to such an extent that it melted the solder. So you see how hot you can get your air. I cannot say exactly how much good that hot air did, but with a properly designed blast heater and oil heater I have no doubt the efficiency would be materially increased.

MR. W. R. ADDICKS—I am using naphtha, and I simply use a coil of pipe which is surrounded by a pipe, or rather by several lengths of pipe, containing oil, which is surrounded by steam at 80 pounds pressure, and approximating 325°. It is the identical style of pipe which was described a few moments ago. We use about a barrel of oil, probably, in 10 minutes, vaporizing it. I have also used two-thirds crude and a portion of naphtha, and it unquestionably improves the results, even with crude oil.

MR. W. H. PEARSON—What is the specific gravity of Lima oil?

MR. R. NORRIS—It runs from 38° to 40° Beaume.

MR. W. H. PEARSON—Our oil is also 38° to 40°—just the same; so that I do not know where the great difference would come in.

MR. F. EGNER—I move a vote of thanks to Mr. Norris for his very instructive and interesting paper. I am sure we can appreciate it much better when we see it in print than we can at the present time. (Carried.)

Appointing a Committee on World's Fair Exhibits

Mr. A. E. Boardman—I want to move, in conformity with the recommendation made in the report of the World's Fair Committee (which has been received, and the committee discharged,) that a World's Fair Committee of seven be appointed by the Chair from members of the Association who are engaged in the manufacture of gas appliances, with a view to having as many gas appliances and applications of gas as possible displayed at the exposition.

Mr. G. W. Graeff, Jr.—I most heartily second that motion.

The President—It has been moved and seconded that the Chair appoint a committee, to be known as the World's Fair Committee, to consist of seven members of this Association representing the industries associated with our business—manufacturers of gas apparatus, etc. Are there any remarks?

Mr. F. Egner—I think it would be better to include all the manufacturers of gas appliances that are members of the Association, and thus to make a very large committee. Then they could organize, and would have the moral support of the American Gas Light Association.

Mr. A. E. Boardman—I am perfectly willing to accept the amendment, or to have the Association say what the number shall be. I thought the number I named was sufficient to get a good and efficient committee from; but, I would suggest, in order to meet the difficulties that may arise, that this committee have power to add to their number.

The President—Does Mr. Graeff second the motion as now amended?

Mr. G. W. Graeff, Jr.—Yes.

The President—Then the motion now is that a committee of seven, representing these industries, shall be appointed by the Chair, and that this committee, when appointed, shall have power to increase its own membership from that same class of gentlemen, who are also members of the Association. Does any gentleman desire to speak to the question? If not, all

those who favor the adoption of this motion will say "aye;" the contrary, "no." It is carried, and the Chair will announce the committee in a few moments.

The President subsequently announced the following as the World's Fair Committee, pursuant to the above resolution:

T. J. Hayward, Baltimore, Md.; Wm. McDonald, Albany, N. Y.; C. W. Isbell, New York City; G. S. Page, New York City; John McIlhenny, Philadelphia, Penn.; A. D. Cressler, Ft. Wayne, Ind.; H. M. Hubbard, Chicago, Ill.

MR. C. H. NETTLETON—While on the subject of this World's Fair Committee I would like to say a word in reference to the erection of a building at Chicago. You all know that at the last Exposition, in Paris, the gas interests put up a very handsome building, and the Commissioners at Chicago have suggested that we might do the same thing. It has occurred to me that it would not be very difficult to raise a very large amount of money among the various gas companies throughout the country, if the thing was only brought to their attention in a proper manner. For instance, if one hundred companies, the size of the one which I represent, were to contribute $100 each, it would give $10,000 at once. Surely every company of the size of mine can well afford to invest $100 for the purpose of having the subject of lighting, heating and cooking by gas thoroughly shown up at the Fair. I sincerely hope that *the new* committee will not hesitate to call on the gas companies, if they find they need money and can use it to advantage. For one I shall be very glad to contribute in proportion to our means. (Applause.)

MR. W. H. PEARSON—I am very glad to hear Mr. Nettleton's remarks. I was going to say I feared that the gas industry was not going to be properly represented at the Chicago exposition; but I think that the gas companies of this country, with the help of a few of the gas companies of Canada, will be able to put up a building which will do us credit. Our Gas Company alone spent $2,500 in giving an exhibition in Toronto 8 or 10 years ago; and I think that if a Company of the size of ours could do that, certainly we have the right to expect that the many gas companies in the States who will pull together, can

put up a building which shall be satisfactory, and in which a proper and creditable display of gas appliances can be made. (Applause.)

THE PRESIDENT—The Chair would be delighted to know that the gas industries of the country would be properly represented at the World's Fair, but your committee did not receive much encouragement when talking with the large companies on the subject. Perhaps the smaller companies will be willing to put their shoulders to the wheel and raise the necessary money; but the larger companies said "No" with considerable emphasis. The committee named by the Chair represent the various industries as well as the Chairman could, in the time at his command, make the selection; and as the committee have power under the resolution to increase their number to an unlimited extent, if the Chair has made any mistake in naming the committee they have it in their power to apply the remedy. They can have as many, and as strong men as they please to pick out; and the Chair sincerely hopes that their efforts will be fruitful of good results.

RESOLUTIONS TENDERED TO THE RETIRING SECRETARY.

THE CHAIRMAN—Has Mr. Addicks, the Chairman of the Committee on Resolutions, anything to report?

MR. W. R. ADDICKS—I will say that the committee have not yet had an opportunity to draw up their resolutions, and I would suggest that when prepared they be put on the minutes of this meeting without being previously reported to the Association.

THE PRESIDENT—The committee on the subject of resolutions to be sent to our Secretary, Mr. C. J. Russell Humphreys, desire an extension of time, as they are not prepared to report at this session. Of course it is not necessary that the matter should be hurriedly reported, and the Association wants the thing done nicely and properly. I think the request of the committee to have their time extended is a proper one, and that we can trust to the committee to properly prepare and deliver the resolutions after the adjournment. If there is no objection

the time of the committee will be extended as much as they may deem necessary.

(*Note by the Secretary*—The committee on resolutions, in accordance with amended instructions, later reported the resolutions as shown below.)

Whereas, Mr. C. J. R. Humphreys has tendered his resignation of the position of Secretary of the American Gas Light Association, and,

Whereas, In his enforced absence from the meeting at which the Association reluctantly consented to permit the severance of his official relations to it, he has taught it how much of the pleasure of the yearly gatherings has been due to his kindly presence ; therefore be it

Resolved, That the American Gas Light Association, in accepting the resignation of Mr. Humphreys of the position of Secretary, which he has occupied to his own honor and its advantage for eight years, testifies by this writing to its appreciation of his intelligent and unremitting efforts to advance the interests committed to his care; and its regret that to these interests he feels he can no longer give the attention their importance seems to him to demand;

Resolved, That these resolutions be spread upon the minutes of the Association and published in the *American Gas Light Journal*, *Light*, *Heat and Power*, *and Progressive Age*, and that a suitably engrossed copy be sent to Mr. Humphreys.

THE QUESTION BOX.

The President—The Question Box is the only matter now before us. The Secretary will read the questions.

Question 1—"*What has been the result of gas companies furnishing gas by contract?*"

The President—Is any gentleman able to give an expression of his experience in this matter?

Mr. W. S. Bowen—The Company with which I was connected a few years ago did some business in this direction by

way of meeting the opposition of an electric light company. In a small town such as ours was the loss of many customers meant a considerable decrease in the output of gas, and we arranged a schedule of prices which we thought would meet the prevailing rates as charged for electric lighting. After an experience of a few years in this direction we found that while we were being imposed upon by some people, there were others with whom we might deal in this way with great profit. Our experience during the last five years has been that during that time we have sold, in round numbers, about 9,000,000 feet of gas, at an income to us averaging $1.25 per 1,000 feet. That is somewhat less than our regular prices for gas would be; but, as I stated before, while we lost, or appeared to lose money on some customers, we made it up on others, so as to make the average about even. It has had another good effect in this particular—that the very class of customers whom we were able to hold while making these rates were those whom we could not otherwise supply with light—they would have gone to the electric light company anyhow; and by lighting these offices, stores and other business places, we kept our gas light prominently before the people. It was our interest to always keep those places properly lighted by seeing to it that the burners and fixtures in those establishments were of the proper kind, and were kept in good shape, so that we might always point to them as our advertisement of the utility of gas lighting. I might say the experience of our Company has been quite satisfactory in that direction, and that we see no reason why we should not just as well continue that practice as to light street lights by contract, as has been the custom for many years.

The President—The Chair being engaged at the moment of commencing your remarks, did not understand whether you are furnishing gas by contract through a meter, at a stipulated price per 1,000. What was the contract?

Mr. W. S. Bowen—The contract is at so much per month, regardless of burning. For instance, we contract to light a given number of lights at a given price per month. I might say in all the places that lighted in this way we have kept our meters set and had regular monthly readings of the meters, and

so at the end of a few months, or at least at the end of the year, we were able to form a pretty correct idea of the probable consumption; and where we thought it was necessary we were able to intelligently raise the contract price, as we had to do in some instances.

THE PRESIDENT—It has been the experience of the Chair in that direction, that in competing with the incandescent light we never made a single contract with anybody at a price per month that the user did not immediately increase from 30 to 50 per cent. on the agreed consumption, so we had to stop it in every instance. Very greatly to my surprise this was true of some of the apparently most reputable merchants in the town. Our experience was such as to convince us that the very worst thing we could do was to sell gas to a man by contract, unless it was contracted through a meter. If no other gentleman desires to speak further in elucidating this question, we will consider it fully answered.

Question II—"What success has been attendant upon the use of explosives for cleaning stopped services?"

THE PRESIDENT—Have any gentlemen had experience in the use of explosives—other than those of expletives—in the cleaning of stopped services?

MR. J. E. NUTE—While I have had no experience myself of the clearing of services by explosives, I may mention one instance which came to my knowledge, where a regular horse pistol was arranged with a thread on one end to fit the top of the lamp post, and then, a charge of powder having been inserted, the pistol was exploded with the result that, with a sufficient charge of powder, you could nearly blow the service to pieces.

THE SECRETARY—The next question has not been put in the usual form, but as the gentleman who put it is not here, and cannot take it up afterwards, and explain it more fully, perhaps I had better read the letters which I received from him: (Reading) "I would like to have information from some of the members, during the meeting, in regard to the effect of unpurified water gas on holders. My attention was called this A. M. to a bad leak in the up and down seam of our relief holder. On

examination, I found the joint to be open 10 inches. Cause, either the rusting of the plate or the riveted part of the rivet. I also found the sheets very thin, caused from the internal rusting of the sheets, as the outer part is quite free from rust. The gas goes into the holder warm, and with considerable moisture from the absorption of moisture from the wash-box, and I suppose some steam. The water from the drip of the inlet is pumped into the holder tank. The water in the tanks shows very dark, although there is a constant stream of Mississippi, unclarified water going into it, so as to change the water as much as possible. We also use much water in the washbox to try and keep the dust from the take off pipe. I have repaired bad leaks on the crowns of holders when we were making *coal gas*. Although some of the patches were large, the sheets were generally pitted, not weakened—as I generally find in these cases, and it is a delicate operation to do this repair, especially as it takes a seemingly small portion of the gas *internally* to make a man quit work, as I have experienced this A. M., and on many other occasions. My question would be as previously stated, and also as to the experience any of the members may have had in patching badly rusted or very thin plate. The method of boring holes, shape and size of bolts used, distance apart, and material used for the joint. The holder next to the relief holder, same size and built at the same time, seems to be in first rate order or condition. It is used for the commercial gas. Hoping to get the desired information, I remain." (Reading second letter from same member). "I had forgotten to mention that the relief holder was built in 1870, and has been used to date; from 1870 to 1884, on coal gas; from 1884 to November 2d, 1888, on coal, oil and water gas; from November, 1888, to date, on water, or *blue gas*. The top section seems to be in better order than the bottom section, and the top sheets of the bottom section better than the lower sheets. We have two holders in use over 40 years, and they seem to be in good order. Another in use 33 years, looks first rate. One of the over 40 year holders had a crown put on about ten years past. Most of the sheets were very much rusted, others had hardly a spot on them." I will say further that from what I know of the works this is not unpurified carbureted water gas, but unpurified non-

Chas. Turner

[redacted]

carbureted water gas, the same as they get in the New York Municipal.

MR. A. S. MILLER—I think, from the way the paper reads, that the trouble was in the holder tank and not in the holder itself. The effect seemed to increase from the top of the holder down to the bottom, and I should judge by that that the trouble is with the Mississippi water in his tank, and not with the gas.

MR. WALTON CLARK—Mississippi water will not hurt iron. There is a holder at that same gas works which has been in use for 40 years, and the Mississippi water has not hurt it; it is as good as ever. I think the trouble is that the gas goes in hot, carrying steam from the generator. There can be no doubt that in blasting, sulphurous acid is produced; and if, as may be the case, from careless manipulation at any time, any amount of blast gas is permitted to go with the crude water gas, it would carry with it a certain amount of sulphurous acid. Efficient scrubbing removes that, and inefficient scrubbing will not remove it, and the probability is that a certain amount of sulphurous acid got into the holder, and the steam, condensing on the inside surface of the holder, forms sulphuric acid by oxidation, or at any rate it was there in the form of a solution of sulphurous acid which would attack the holder sheets. If the gas had been properly scrubbed or condensed, there would have been no sulphurous acid present. From what has been said, and from hearing the letter read, I believe I know the works. If so, I have myself, at those works, found sulphurous acid in the wash box—I am satisfied that it all comes from the presence of sulphurous acid in the water gas.

MR. W. H. PEARSON—Does not Mr. Clark think Mr. Slater, who has given up the use of water in his scrubbers, would be liable to the trouble complained of? Would not sulphurous acid reach his relief holder?

MR. WALTON CLARK—I do not think it would. I understand he gets his gas so cold that there is no steam going into his holder. If he does, he takes steam that is carrying sulphurous acid, and sulphurous acid is very soluble, and the steam when condensing would certainly carry it out with it.

Mr. F. B. Crowell—We have two holders in use at our station, which have been there for about ten years, used for hydrogen gas. The gas goes directly from the generator, and is therefore very hot, and carries a large amount of steam with it. I have one holder at present open, and it seems to be as good inside to-day as it was the day we put it up. We have never had any trouble with it at all. We keep quite a stream of water running in each of them, and we find that in time the water gets very foul and black.

Question IV—"What is the best method of using naphtha as an enricher in small works?"

The President—That is a question of great interest to the large class of our members who are engaged in the gas industry. Will some gentleman briefly suggest what in his judgment is the best method of using naphtha under those circumstances?

Mr. A. E. Boardman—Not being interested in any patent apparatus, I would like to state that having tried to use naphtha to enrich gas I believe the best way is to make carbureted water gas, and then mix the two gases.

Mr. W. R. Addicks—Within a month we started up one of our works, and had an opportunity to measure the uncarbureted water gas, and then the gas that was finally carbureted, and we found that in using the oil naphtha in the retort we got a yield of 80 cubic feet, and candle-feet per gallon of 3,800, thus showing very poor efficiency for using naphtha in the retorts without coming in contact with carbureted water gas. I will say, however, that I had some information yesterday which throws some light on this subject. We pass all this gas through the wet purifier; and I shall have to investigate as to whether that has any effect upon the candle power.

The President—Nearly every gentleman present has tried to enrich his coal gas by using crude oil or naphtha in some way.

Mr. J. Somerville—I will state an experience which might help him out. I was short of cannel at one time and had to use oil and naphtha. I could not work it satisfactorily in a retort, so I took the oil to the coal shed and mixed it with a quantity of dry slack coal until it was perfectly absorbed and

the coal was dry. With the material in that condition I took a few shovels of it and put it on each bucket of coal that we took into the retort house. I found that I got the best satisfaction by that method. It is possible the writer of that question will try that plan; not having a water gas apparatus, it might succeed.

MR. J. M. RUSBY—Some time since a series of articles appeared in the *Journal of Gas Lighting* with reference to the Maxim process, in which the coal gas was enriched with naphtha vapor. The naphtha was vaporized by means of steam, and put right into the main inlet of the holder. For some time there were very favorable reports of the result, but I have not heard from it of late. That was a year ago. If any other member has heard of it since that time, it would be very interesting to know what results have been attained.

THE PRESIDENT—Has any member noticed the effect of using naphtha in the manner suggested?

MR. I. BUTTERWORTH—I have been asked to tell what we are doing at Columbus. We are there enriching coal gas with naphtha. This question asks for the best method. I will not pretend to answer that question, for I can simply state what we are doing. We run the naphtha by gravity into an ordinary coal gas retort—one of a bench of sixes—five retorts being used for carbonizing coal at the same time. We run in about half a gallon of oil per 1,000 feet of gas made. After filling the front of the retort with loose firebrick the oil is passed back through the retort towards the rear through a 3-inch pipe. By regulating the heat and adjusting the size of the stream of naphtha accordingly, we have found no trouble from the deposit of carbon.

THE PRESIDENT—The Chair has had an experience with the use of naphtha and crude oil in enriching coal gas, and never found anything superior to the method which Mr. Butterworth describes. I think that nearly all our New England men at one time and another have enriched their coal gas in practically a similar way. I know of nothing which is superior to it.

Question V—"What size of purifiers should be had for oxide with make of 200,000 cubic feet per day?"

THE PRESIDENT—Brother McMillin and myself are struggling for a living down in Pine street, and are trying to do this sort of thing right along; and Mr. McMillin desires me to thank the Association that they are not tearing the shingles off his new roof. I think that question is answered.

Question VI—"What per cent. of free sulphur should spent oxide contain?"

THE PRESIDENT—If any gentleman engaged in purifying his gas with the use of oxide has made any examination of that subject, and desires to impart the information, we shall be glad to have the question answered.

MR. T. LITTLEHALES—I think it can be very satisfactorily worked, and with fair economy, until it contains about 40 per cent. of sulphur, after which time it is a great deal better to buy new oxide than it is to go to the labor of throwing in so much inert material; but I think it can be worked with fair economy up to about 40 per cent. Of course with the oxygen process it can be carried very much further than that, but the English practice is to run it to about 45 per cent.

MR. E. MCMILLIN—I suggest that if the previous question could have been answered, it would have thrown some light on this. If a man who is making 200,000 cubic feet per day has very large boxes, he can run his oxide longer than one who has small boxes.

THE PRESIDENT—But I notice at the same time that you give away no merchantable information. (Laughter.)

Question VII—"Would it pay large gas companies to collect their bills through the American Express Company? Has any member ever tried that plan? Why the 'American' especially?"

MR. G. A. YUILLE—I think it would be well to occasionally bring before this Association questions connected with the selling of gas. We have to do with making gas, and are endeavoring to find means of making it as cheaply as possible; but there is seldom any discussion with us upon the point of selling it.

We all know that there is a great deal of dissatisfaction among consumers of gas; and we know that it arises in the manner in which it is sent to them, and the opposition against their using it which the gas companies all have. What we want to-day is to put gas into the houses in the best kind of shape, and then to let them pay their bills in as convenient and smooth a manner as possible. In Chicago the American Express Company enables consumers to pay their gas bills at a number of different points, and so they are not compelled to come to the gas office and waste an hour or more in order to settle up their accounts. In Chicago about 30 per cent. of the bills are paid through the Express Company. It relieves the Gas Company, and makes it very convenient for the consumer.

The President—The Chair understands that in Chicago two years ago a very large percentage of the bills of the Gas Company was collected by local express companies—in this case I believe by the American. Instead of the consumer having to go to the gas office to pay his gas bill, he can walk to the office of the Express Company in his immediate neighborhood and pay his bill, and the Express Company gives a receipt.

Mr. G. T. Thompson—We have a similar system in St. Louis, but in our case only about 17 per cent. of our accounts were paid to the Express Company. The fee for collection on bills under $25 is 5 cents, a portion of which goes to the Express Company for handling the money, and a portion to the men who collect the bills—in our case usually druggists. We have about 30 offices throughout the city of St. Louis which receive payment of bills up to the 10th of the month, which is our last discount day. After the discount day is over all bills must be paid at the office.

Question VIII—"Will it pay to utilize hydraulic main liquor of one or two ounces strength, such liquor running into a well by itself, separate from the scrubber liquor? And by what process can it best be utilized?"

The President—Cannot Brother Page elucidate that a little?

Mr. G. S. Page—The question undoubtedly refers to one or two ounce liquor. If of two ounces strength it would pay to

run it to an ammoniacal liquor tank, after separating the liquor from the tar so that as small a percentage of tar as possible goes forward to the ammoniacal liquor tank. It is rather more difficult to work, and yet in practice it has been found to be economical to save liquor of that strength.

Mr. C. H. Nettleton—At the works in my charge all the liquor runs from the hydraulic main to the tar well, and from there to the ammonia water well; and when by any chance the liquor becomes so weak that it cannot be used economically in the concentrator, it is pumped into the standard washer about midway its length, and in that way the strength of all the liquor in the well is increased.

Question IX—" What comes properly into the account in estimating the cost of gas in the holder?"

The President—I believe that from the snow clad hills of Maine, down to the warm waters of the Gulf, where our friend Clark once came from, that old question is reverberating all the while. Everyone has tried to answer it but no two persons have ever yet agreed.

Mr. Walton Clark—There is one comprehensive answer to that question, and that is, all the items which go to make up the cost of the gas.

The President—That concludes the questions, and also the business of the Association, unless some member has something to offer under the head of new business.

Votes of Thanks.

Mr. W. A. Stedman—If the business of the Association is concluded, I want to make a motion. We owe a cordial vote of thanks and of appreciation to our Acting-Secretary, Mr. A. C. Humphreys, for the very efficient manner in which he has discharged the duties which were so suddenly thrust upon him. We all know how it is in the life of a busy man. He gets absorbed in the details of carrying on his own work to that extent that it is very difficult for him to divert his mind from his work, and to do thoroughly and efficiently every task which may be

suddenly thrust upon him; but in the present case I leave it to the members to judge how efficiently the work of the Secretary has been done, and how heartily it has been undertaken. It is true, perhaps, that it was largely a labor of love in his case, but nevertheless it has imposed upon the Association a very great obligation for the manner in which he has discharged the duties which became so unexpectedly his. I appreciate, as I think all the members do, the gentlemanly and persistent way in which he has forced the recreant members to chip in their back dues, as well as their front dues. I think, considering the very little time he has had to get at them, he has had very remarkable success in bringing them up to the Captain's office and having them settle. I know the Association will join in a very hearty vote of thanks; and I wish it had fallen to the lot of some one abler than myself to express in a fitting manner the obligation which we all feel towards our Secretary. Of course we are all sincerely sorry for the absence of our regular Secretary, but in his absence I can conceive of no one who could have more efficiently performed the duties of the office than the gentleman who has so kindly taken them upon himself. (Applause.)

MR. C. H. NETTLETON—I heartily second the motion which Col. Stedman has so sincerely made. The work, as we all know, has been done very thoroughly; and when I tell the members that Mr. Humphreys held the Council from 8 o'clock until 1 o'clock, the night before the meeting, and kept us going every moment, you will understand the amount of preparation which he put into our work. I heartily second the motion.

THE PRESIDENT—It has been regularly moved and seconded that a vote of thanks is due from this Association, and is hereby tendered to Mr. Alexander C. Humphreys for his faithful fulfillment of the duties of the Secretary during this meeting, and preceding the meeting. Does anyone desire to say anything in connection with this motion other than has been said. I will ask all those who favor the adoption of this motion to rise. I will spare myself asking for the negative vote. I have the pleasure of assuring you, Mr. Humphreys, of the unanimous thanks of this Association for the very hard work which you have performed for the Association, for the manner in which

you have done it, and for the zeal which you have shown in that work; and I beg to say to you personally that this expression of thanks finds a hearty echo in my own heart. I have known something of the labors of the Secretaryship (for I did them awhile), and I thought that your brother was one of the best of Secretaries, and have felt that we were about to dispense with the services of the best Secretary we have ever had; but I think that I said yesterday, in the few remarks that I made, that you gave us an idea of how efficient a Secretary you could be if you tried. I feel that it is a fortunate thing for us that we had you to call upon, and that it is fortunate for the gentleman who is to succeed you in the Secretary's office that he has such an example to look to. I assure this Association that never in my life, in connection with the various Associations and bodies to which I belong, have I ever seen the same amount of work, so promptly and systematically done, and the whole story of the work laid before the Board of Directors so thoroughly, as were the statements that were laid before this Council by Mr. Humphreys, our Acting-Secretary. (Applause). You simply have done yourself an honor in honoring this gentleman as you have by your vote, and I thank my good fortune that I have had the pleasure of saying what I have.

SECRETARY HUMPHREYS—Gentlemen of the Association. I thank you for the motion that has been carried in my favor. I thank Col. Stedman for the very happy way in which he brought it to your attention, and I thank the President for the way in which he has tendered the thanks of the Association to me. I think that I may say, without saying anything that I ought not to say to the Association, that Col. Stedman hit the mark when he said that it was with me a work of love; and if in doing my duty by my brother I have also done my duty by the Association, then I am doubly pleased. I thank you sincerely for your expression of appreciation. (Applause).

MR. WALTON CLARK—I move a hearty vote of thanks to our Acting President for the able manner in which he has filled his temporary office.

MR. A. C. HUMPHREYS—I have great pleasure in seconding that motion.

VICE-PRESIDENT BOARDMAN—Gentlemen, you have heard the motion, duly seconded, that a vote of thanks be tendered to our Acting President for the manner in which he has conducted the present meeting. All in favor of that motion will signify it by rising. Mr. White, I have the pleasure of announcing to you that you have the hearty and unanimous thanks of the Association for the manner in which you have conducted the business of this meeting. (Applause).

ACTING PRESIDENT WHITE—I thank you. I will simply say I have endeavored to the best of my ability to fulfill the duties that were entrusted to me so suddenly and unexpectedly. You all know how much I regret the necessity which called upon me to preside. It was something that Mr. Harbison had looked forward to with a great deal of pleasure and with anticipations without measure, but unfortunately he has been deprived of it. If I have merited these thanks I am glad to have received them. I have tried to be fair and strictly impartial. If I have not been, I regret it. Again I thank you.

On motion of Mr. Boardman, seconded by Mr. Egner, it was

Resolved, That the hearty thanks of this Association are due and hereby tendered to Messrs. Wm. R. Beal, Oscar B. Weber, Wm. H. Bradley, Eugene Vanderpool, Fred S. Benson and Wm. H. White, comprising the Committee of Arrangements, for the considerate and efficient manner in which they have planned and carried out the arrangements for this meeting; and for the courtesies extended to the ladies accompanying members of the Association, and also for the promised entertainment of Banquet and Excursion.

The Association then adjourned.

APPENDIX.

A LIST OF WATER GAS REFERENCE PAPERS, ETC.

Corrected by F. H. Shelton, from date of his paper,* October, 1889, down to date of July, 1892.

GENERAL PUBLICATIONS AND GAS JOURNALS.

The files of the "American Gas Light Journal."
" " " "Progressive Age and Water Gas Journal."
" " " "Light, Heat and Power."
" " " "The Official Gazette of the U. S. Patent Office."
" " " "Proceedings of the American Gas Light Association."
" " " "New England Association of Gas Engineers."
" " " "Western Gas Association."
" " " "Ohio Gas Light Association."
" " " "Society of Gas Lighting of New York, N. Y."
" " " "Guild of Gas Managers of Boston, Mass."

Also miscellaneous and special articles appearing chiefly in the "American Manufacturer and Iron World," "Scientific American," "Scientific American Supplement," "Age of Steel," "Engineering," and other technical and trade Journals.

SPECIAL PAMPHLETS, PAPERS, REPORTS, ETC.

Water Gas: Its history and manufacture. Morton. "Sanitary Engineer," Oct. 1869.

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* See p. 154.

History and value of Water Gas Processes. Pamphlet by John Torrey, 1864.

Review of coal gas and water gas companies. Reprint from "Cincinnati Enquirer," of 12–19–'81, St. Louis, 1883.

Report on Water Gas. By a special committee of the Franklin Institute, Philadelphia, 1886.

Water Gas. Paper by J. F. Bell. "American Manufacture and Iron World," July 19, 1889.

Water Gas in the United States. Book form, pamphlet. Alex. C. Humphreys, Philadelphia, 1889.

Carbureted Water Gas. Paper before British Gas Institute, by A. G. Glasgow, 1891.

The Waste of Energy in the Production of Water Gas. Paper before Society of Gas Lighting, Eugene Vanderpool, 1879.

A letter to the Corporation of the City of Toronto upon the gas supply. W. H. Pearson, 1880.

Carbonic Oxide: Is it a harmless anæsthetic, or a virulent poison? Prof. H. Morton, N. Y., 1878.

Water Gas is poisonous. Authorities collected by H. E. Young. Charleston, S. C., 1880.

Proposition—Water Gas is Dangerous. Charles V. Shepard, Charleston, S. C., 1880.

Some facts relative to Water Gas and competing Companies, Charleston. S. C., 1880.

Communication regarding Water Gas and the charter of the Municipal Gas Manufacturing Co., Charleston, S. C., 1880.

Have you seen their "scare-crow"? Water Gas a dangerous poison. Fulton Municipal Company, Brooklyn.

Water Gas—Is it a dangerous poison? Brooklyn.

Information that is important. Reprint from American Gas Light Journal, March 16, 1885, Chicago.

The Regulation by the State of the Profits of (Gas) Corporations.

Illuminating Water Gas proved a Deadly Poison, New York, 1882.

What is meant by the Candle Power of Illuminating Gas? Rochester, N. Y.

Memoranda upon the Production of Water Gas. W. W. Farmer, Proceedings of Society of Gas Lighting, 1884.

Water Gas: What is it? How is it made? What becomes of it when it is burned? Reprint of Granger pamphlet by the Unit. Gas Improvement Co., 1891.

Competition of the Manufacture and Delivery of Gas. Argument by A. J. Hickenlooper, Cincinnati, 1881.

AMERICAN GAS LIGHT ASSOCIATION, PAPERS.

A New Process of making Water Gas. T. G. Fogarty, 1882.

Illumination vs. Candle Power. A. C. Humphreys, 1887.

Advantage of supplying a mixture of Coal and Water Gas. T. H. Lansden, 1889.

Illuminating Water Gas: Past and Present. F. H. Shelton, 1889.

Practical efficiency of an Illuminating Water Gas Setting. A. G. Glasgow, 1890.

Theoretical effect of Preheating blast, steam and air in Water Gas manufacture. R. Norris, 1891.

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Loomis Gas Machinery Co. Illustrated descriptive catalogue, 1891.

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An improved method for producing light and heat. National Gas Company, Philadelphia, 1876.

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Facts not fancies, regarding Water Gas. American Gas, Fuel and Light Company, 1881.

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Gas generato nd heating gas by the Pratt & let and circular. Chicago, 1888–9.

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Report on scope and validity of certain patents granted H. C. Rew. B. R. Catlin, Chicago, 1889.

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SANDERS:

The Water Gas correspondence. Pamphlet published in Philadelphia, 1860.

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A reply to Mr. W. L. Brown's paper, etc., 1889.

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STRONG:

The Strong process for fuel gas. American Gas, Fuel and Light Company, New York, 1883.

Also in Barr on "Combustion of Coal." Indianapolis, 1879.

TAYLOR:

The Taylor Revolving Bottom Gas Producer. Philadelphia. Descriptive catalogue, three issues, 1889–90–91.

TESSIE DU MOTAY:

Communication on the Oxygen process. B. H. Barthol, Washington, 1876.

A statement showing the explosive and poisonous character and constituents of the illuminating gas known as oxygen, water gas, etc. B. H. Barthol, Washington, 1876.

Description of the "Municipal" process. American Society Civil Engineers, New York, 1885.

VAN STEENBURG:

Circulars of "The American Water Gas Works Construction Company." New York., 1888.

VAN SYCKLE:

Advertising circular.

The above is an approximate—though not a complete—list of water gas literature. The writer is endeavoring to make it as complete as possible, however, and would be glad if any one knowing of other references than appear in the above, would send him a copy of the same, or at least, names or titles, etc.

F. H. SHELTON,

813 Drexel Building, Philadelphia, Pa.

In Memoriam.

God's will be done! Whose gracious will
Through all our mortal fret
One sacred blessing leaves us still:
To love—and not forget.

C. H. NASH,
St. Louis, Mo.,
Died November 9th, 1888.

JOHN CARTWRIGHT,
Poughkeepsie, N. Y.,
Died December 19th, 1888.

C. F. MAURICE,
Sing Sing, N. Y.,
Died December 24th, 1888.

ROBERT P. SPICE,
London, Eng.,
Died May 11th, 1889.

EDWARD J. KING,
Treasurer, etc., Jacksonville, (Fla.) Gas Light and Coke Co.,
Died October 28th, 1889.

OLIVER E. CUSHING,
Agent Lowell (Mass.) Gas Light Co.,
Died January 17th, 1889.

In Memoriam.

THEOBALD FORSTALL,

President Chicago Gas Light and Coke Co.,

Died January 19th, 1890.

WILLIAM PARRISH,

Treasurer Seneca Falls (N. Y.) and Waterloo Gas Co.,

Died January 19th, 1890.

WALTER B. HOUSTON,

Secretary Rahway (N. Y.) Gas Co.,

Died April 3d, 1890.

JAMES H. ROLLINS,

Worcester, Mass.,

Died June 19th, 1890.

GEN. CHARLES ROOME,

Ex-President Consolidated Gas Co., New York,

Died June 28th, 1890.

B. F. SHERMAN,

New York, N. Y.,

Died October 31st, 1890.

NATHANIEL TUFTS,

Manufacturer of Gas Meters, Boston, Mass.,

Died November 9th, 1890.

In Memoriam.

WILLIAM MOONEY,

Gas Engineer, New York, N. Y.,

Died January 21st, 1891.

WILLIAM H. DOWN,

Secretary American Meter Co., New York, N. Y.,

Died February 15th, 1891.

I. LINTON,

President Ravenna (Ohio) Gas and Electric Light Co.,

Died March 1891.

J. M. STERLING,

President Monroe (Mich.) Gas Light Co.,

Died May 18th, 1891.

E. M. RUSSELL,

St. Louis, Mo.,

Died May 28th, 1891.

SAMUEL PRITCHETT,

President Nashville (Tenn.) Gas Light Co.,

Died September 21st, 1891.

Virtus junxit, mors non separabit.

Necrology.

ROBERT PAULSON SPICE.

DIED MAY 11, 1889.

Deceased passed away suddenly and painlessly (at London) on the morning of Saturday, May 11, the primal cause being heart failure, superinduced by a congestive chill.

While we cannot claim that he had been closely identified with American gas engineering in a practical way, nevertheless, on his visit to this country, in 1885—a visit by-the-way, which he had repeated annually since—he attended the Cincinnati Convention of the American Association, on which occasion the Association elected him to Honorary Membership. Another tie that bound him to America was in the fact that his only son —Prof. Spice—is a resident of Brooklyn, N. Y., and now acts as the Gas Inspector for that city.

In conclusion we give the following abstract of Mr. Spice's connection with the English gas industry, compiled from the columns of the London *Journal:* His was a unique place in the ranks of professional men, which can never be filled by another. He belonged to an order of gas engineers who have almost died out. His connection with the management of gas undertakings began with the construction of the works for lighting his native town of Fakenham, in Norfolk, where he was at the time carrying on the business of an iron-monger. Leaving this place, he settled in Richmond, Surrey, where he devoted himself to the management of gas works under leases, according to a very general practice of the time. He opened offices on Cornhill in 1860, about which date and for several

years following he was lessee of the gas works at Wandsworth, Hampton Court, Richmond, and Watford. He also built gas works at Great Yarmouth, Boston (Lincolnshire), Tunbridge Wells, Tattershall, Abingdon, Hartley Wintney, Hoddesdon, and other places. Thus, like most other gas engineers of his epoch, he grew into his place by experience, and held it by a native aptitude for the business of his choice. He was largely consulted by gas companies and local authorities for arbitrations, rating appeals, etc.; and he had an extensive parliamentary practice. He possessed the gifts necessary for an expert —ready wit, keen appreciation of the bearings of a situation, and facility of expression.

He was a regular supporter of the British Association of Gas Managers; often speaking at the meetings. He was elected a member in 1868, and was President for 1876-7, from which period dates the Benevolent Fund, whereof he was one of the first supporters, and moved the resolution upon which the fund was established. Besides being a Past-President of The Gas Institute, Mr. Spice was a Member of the Institution of Civil Engineers, a Member of the Institution of Mechanical Engineers, a Past-President of the Society of Engineers, a Fellow of the Royal Geographical Society, and a very distinguished Freemason. His engineering work has covered a period of a half century; for there is an inscription still in existence, taken from the old Hoddesdon works, bearing the words "R. P. Spice, Engineer, 1847;" and this, as already stated, was not his first piece of construction. That he retained his activity to the end is shown by the fact that his last new gas works, at Riddings, are only just completed, and we believe still await the final certificate.

All who knew Robert Paulson Spice will join with us in lamenting his loss; for a kinder heart never beat. Benevolent to a fault, many went to him in distress and received relief. He was only too open with his hand, and too ready with his support for all who appealed to him for help. He has become known to a wider circle than even his friends and acquaintances through the simple chatty little books in which he was accustomed to write the records of his journeyings as the "Hermit of Westminster," and which reveal his kindly nature.

EDWARD J. KING.

BORN JUNE 14, 1849. DIED OCTOBER 28, 1889.

Deceased was born in Jacksonville, Illinois, on June 14, 1849, in what is now known as the old Bristow house—a veritable landmark of the city—and was the son of the late J. O. King, who passed away on April 16, 1887. His preliminary studies were brought to a close in the public schools of his native city, after which he took a scientific course in the Illinois College, supplementing the latter by a special polytechnic course in an Eastern college. Having completed his education he returned to Jacksonville, where he engaged in mercantile business, meeting with a good share of success, meanwhile devoting much of his attention to assisting his father in the management of the Jacksonville gas works, which had long been in the care of the senior King. Increasing years, together with the rapid growth of the business of the Company, eventually caused the younger King, at the solicitation of his father, to give up all other pursuits to devote himself entirely to the gas business. To be absolutely correct, however, it must be remarked that deceased did remain a member of the local insurance firm of Doan, King & Upham, retiring therefrom when King senior passed away.

He had a large interest in the Jacksonville Manufacturing Company; was a Director in the *Daily Journal* Company, and Secretary of the Business Men's Association. In his religious and social obligations and responsibilities we also find him where men are found. He was a vestryman of Trinity Church, a Trustee of its charitable fund, and ever ready to lend a helping material hand where honest poverty asked for aid. He was a prominent Mason, and was also affiliated with numerous other societies having the promotion of some good for their object.

He was a valued member of the American Gas Light Association, having been elected to membership therein on the occasion of the eighth annual meeting, held in Chicago, 1880. He was a frequent attendant at its conventions, and always warmly welcomed thereat.

In 1887 he was chosen to the office of Second Vice President of the Western Gas Association, going to the First Vice Presi-

dency in '88, preparatory to his unanimous elevation, in 1889, to the office of President. Thus in a double sense is the Western Association bereaved, in that it loses a founder and its reigning President. Well do we remember with what acclaim his election to the chief office was received—but of what avail are these recollections. These memories are now in the first blush of our sorrow hardly fitted [illegible] e with grief.

We will make no attempt a[illegible] rating his record in connection with our common in[illegible] it is an open book to those who keep up in its history.[illegible] discriminating, upright and able, his capacity as a gas n[illegible] had, although often severely tested, never been found [illegible] in scope. All that can be said is said when the sim[illegible] ment is made that as the father was so was the son.

His domestic life was of a[illegible] with his public record—unstained and blameless. He w[illegible] ted in marriage on June 19, 1873, to Miss Ida Sawyer, daughter of Dr. C. K. Sawyer, of Jacksonville. His widow and four children—a son and three daughters—survive him, who mourn in all sincerity the loss of a husband and father in the truest sense of these endearing terms.

The funeral services were conducted by the Rev. Mr. J. C. Fulton, of Boonville, Mo., at Trinity Church, Jacksonville, and despite the short notice—it was necessary to cause the interment without delay—that only could be given, the edifice was thronged with mourners who represented every condition of Jacksonville's citizenship. In conclusion, we can but say, speaking for ourselves, as friend and fellow of deceased, that death has taken away from us in the person of Edward J. King a man whom it was a pleasure to know, and whose memory shall remain with us to the end.

OLIVER E. CUSHING.

BORN MARCH, 1829. DIED JANUARY 17, 1889.

Oliver Edward Cushing was born at Chelmsford, Mass., in March, 1829, and almost within view of his birthplace was the whole of his useful life spent. Having received an education

in the local public schools, graduating with honor from Phelps Academy, in 1845, the tendency of which was to fit him for the profession of an engineer, he, in various positions, proved his worth and merit for business direction, and his success was such that the proprietors of the Lowell Gas Light Company—Chelmsford is but 3½ miles southwest of Lowell—invited him, in 1860, to the post of agent of their Company.

He was President of the Board of Trustees of the Lowell Cemetery, Vice-President of the Five Cent Savings Bank, and Clerk of the Vestry Board of St. Anne's Parish, of which church he had always been an ardent supporter. The only public office held by him was a chair in the Board of Aldermen (1885). Of his immediate family his widow and three daughters survive.

Turning now to his more extended relations with the fraternity of the country, the records show that he was one of the party of sixteen who, at Boston, Mass., on February 2, 1871, subscribed to the original articles of agreement forming the New England Association of Gas Engineers—this meeting being the sequel of the sad gathering at Worcester, Mass., of December 18, 1870, when the remains of the late James B. Blake, ex-Mayor, and Engineer of the Worcester Gas Light Company, were consigned to earth. At the initial meeting of the Association Mr. Cushing was elected one of its Directors, and although he refused thereafter to occupy higher office in its gift, his voice and presence were ever at its command. He was elected to membership in the American Association at the second annual meeting—Brooklyn, N.Y., October 21, 1874—and his course therein was in accord with his history in the New England body. He became a member of the Society of Gas Lighting in 1876, and, if we mistake not, was a charter member of the Guild of Gas Managers, of which organization he was at one time President. Of all these bodies he was a member at the time of his death, and it need not here be said that his loss will be keenly felt by each.

The funeral services were celebrated at St. Anne's Church, January 20, 1890, the ceremonies being conducted by the Reverend Dr. Chambre, a close friend of the deceased. The attendance was of a most noteworthy character, and could one have banished the knowledge of the sad reason why all were gathered in the sacred edifice, it would seem as if a joint conclave

of the Guild of Gas Managers and the New England Association was in session at Lowell.

THEOBALD FORSTALL.

BORN 1836. DIED JANUARY 19, 1890.

Deceased was born in New Orleans, La., in 1836, and traced his lineage back to the earliest French settlers of that section, many of his relatives having taken great part in the religious, civil and warlike events that make up the history of that section of our country when it was yet a French dependence. At an early age deceased was thrown completely on his own resources, and adversity soon developed those latent resources that would have made him successful in any branch of industry, and which did cause his name to be known, almost as a household word, wherever the art of gas making is practiced. In 1856 we find him located in Stillwater, Minn., where, at the age of 20, he was in control of an important business enterprise, relinquishing the same in 1860 to engage in the shipping business at his birthplace. The outbreak of the civil war all but bankrupted him, and next we find him in the confederate army, from which he was soon released as invalid. In 1864 he became a bookkeeper in the counting-room of the New Orleans Gas Light Company, where his great knowledge—deceased was always a remarkably close student and a most retentive observer—soon brought him outside the narrow precincts of the counting-room. Shortly, then, he was named General Manager of the Company, and this was followed by his appointment (in addition to his other duties) as the Company's Engineer. In 1874 he was elected to membership in the American Association—second annual meeting, Brooklyn, N. Y., 1874—and the potency of his personality was soon felt in its affairs. He was an earnest advocate before it of the abolition of Sunday labor in gas works, and his remarks on that subject, while commanding widespread attention to the subject, also directed the notice of his confreres towards himself. Although always something of an invalid, his bodily ills were in no wise reflected in his vigorous mentality. Logical, calm and just, he

was not to be diverted by bombast nor influenced by flattery. Perhaps the ablest paper ever read before the American Association was that contributed by him to the third semi-annual meeting (Washington, D. C., May 1875), on the subject of "The Proper Preparation of Lime for Use in the Purification of Coal Gas." At all events it established completely in this country Mr. Forstall's fame as an engineer. He served the Association as Vice-President in 1881-2, and was its President in 1883. In 1887 he became a member of the Society of Gas Lighting, and joined the Western Association at the Chicago meeting, 1888. There can be no doubt about the fact that to Mr. Forstall's ability and service much of the prestige attained by the American Association is due.

In 1882 three cities—St. Louis, Philadelphia and Chicago—bid for his services in connection with the engineering management of certain gas works. He elected to go to the last named, there to assume the Vice-Presidency and General Management of the Chicago Gas Light and Coke Company, and became President of the latter corporation after the Trust agreement was an accomplished fact—he resigned the Presidency on the occasion of the annual meeting, January 13, 1890. He was, in his leisure hours—unhappily, of late, all too few—a delightful companion, whose delicacy and wit were only outshone by his candor and polish. His wife and nine children survive him.

WILLIAM PARRISH.

BORN APRIL 23, 1828. DIED JANUARY 19, 1890.

Deceased, who succumbed, on the morning of January 24th, to an attack of pneumonia, was born at Canandaigua, N. Y., on April 23d, 1828, and was educated at the Canandaigua Academy. Having graduated, he visited the West, and on his return therefrom engaged in business at Buffalo, N. Y. In 1868 he succeeded his brother Stephen in the general charge of the Seneca Falls and Waterloo Company, remaining in this position until death severed the connection. Deceased was elected to

mem p in the American Gas Light Association in October, 1881, was a frequent attendant at its sessions. He served his Company faithfully and efficiently. His only public office was that embraced in a three years' term as Superintendent of the County Poor, the responsibilities attaching to which were borne in most worthy manner. A local authority, in a sketch of the life of deceased, says: "In his demise our village loses a citizen whose place can y filled. His many acts of kindness, his genial pres is sterling manhood, will long keep his memory was one of the kindest of parents, a loving husban g neighbor and an accommodating friend, whose ply regretted by the entire community. To the f r affliction sympathy and condolence will go fort rom the hearts of strangers as from those of friend

WALTER BURCHARD HOUSTON.

Born 1864. **Died April 3, 1890.**

Deceased, who was in his 26th year, became identified with the Rahway Gas Company, and so well did he serve his apprenticeship therein that the proprietors, appreciating his worth, finally named him to fill the triple place of Secretary, Treasurer, and Superintendent. He accepted these duties at a time when the fortunes of the Company were at a very low ebb; but imbued with the idea that hard work and liberal management would restore the property to its original position, he applied both restoratives with unflagging zeal. As is not infrequently seen, when his efforts had been crowned with success, even to the point of putting the Company on a dividend paying basis, he was not permitted to enjoy the full fruit of his labors; for about the close of the spring of 1888 he was seized with hemorrhage of the lungs which eventuated in chronic phthisis. In the hope of alleviating, if not conquering the symptoms of his disease, he journeyed to Arizona, but failed of the hoped for relief. He returned home last fall, to linger until the summons should come, and death's messenger was never received with

greater resignation. In fact, from personal knowledge of the circumstances, we cannot refrain from expressing our admiration respecting the placid, uncomplaining manner with which deceased bore the ills that afflicted him. He was elected to membership in the American Association at the meeting held in New York city, in October, 1887, and was much interested in its welfare. His illness, beginning as it did shortly after his election to the Association, alone prevented him from becoming prominent in its affairs. He was a progressive engineer, a close student and a thoroughly cultured gentleman.

JAMES HENRI ROLLINS.

BORN 1836. DIED JUNE 19, 1890.

James Henri Rollins was born at Melvin, N. H., in the spring of 1836, and having acquired a common school education, was early attracted to the possibilities involved in the development of the gas business. The first safe record that we have of his connection with the business is his service with the Boston Gas Light Company. Apt and bright, he mastered the details of the craft with such speed that, the opportunity offering, he accepted a contract to build a works at Cairo, Ill. This task completed he returned East to accept a position with the Brookline, Mass., Company, where he remained until October, 1870. At that time an inviting field opened up to him in the shape of the position of Manager and Superintendent of the Minneapolis, Minn., Company, in the service of which he remained 5 years, acquitting himself with signal ability, as the records of that Company amply prove.

In 1875 a call for duty summoned him once more to the East, and in the fall of that year we find him in the harness as successor to Mr. F. C. Sherman (who resigned from Worcester in order that he might take service at New Haven, Conn.) as Agent for the Worcester, (Mass.) Gas Company. His faithful and valuable labors at this point are too well known to the fraternity to call for extended comment. Suffice it, then, to say, that

they were of a nature which gave credit to himself, profit to his employers, and satisfaction to the Company's patrons. Failing health alone compelled him (in the spring of 1887) to resign from active duty, and since his retirement his failing days were those of acute bodily pain. His strong mentality, however, remained to the end, and his anguish was, in consequence, all the more pronounced. Ever active in promoting the best interests of his profession, it is therefore not to be wondered at that his name appears on the rolls of several of our Associations, and that it was so written in the early days when many doubted whether or not the policy of meeting in open communion was a safe means for the advancement of gas engineering. Whether or not Rollins was a doubter in this regard is best answered by noting that his name appears on the roster of the American Association at the meeting held in October, 1873, although we believe the first meeting he attended was held in New York, in 1875. He was an ardent supporter of the Association, and although the only office held by him in it was as member of the Executive Committee ('82–'83), he often assisted in guiding it smoothly in trenchant debate.

He was a man of great strength of character and mind, an engineer of marked ability — both executive and technical— whose methods and results were always abreast the times. As a manager he caused everything to be secondary to and for the advancement of the interests of his employers. Honest and trustworthy as an employee, he was equally rated to acquire and retain the esteem and unrestrained affection of his friends. True as steel, his steadfastness to his friends was a type of that manhood which safely passes through the crucible of time; each successive year but proving the fine grain of his affection. In Masonic orders he attained high rank, and claimed kinship with the Quinsigamond Lodge of Masons, Eureka Royal Arch Chapter, Hiram Council and Worcester County Commandery of Knights Templar. The burial services took place at his late residence, on Monday, June 23, the Reverend Dr. Means, of Piedmont Church (of which Mr. Rollins had long been a faithful member) officiating

GENERAL CHARLES ROOME.

BORN AUGUST 4, 1812. DIED JUNE 28, 1890.

Deceased was the son of Nicholas Roome, who at the time of the birth of the deceased was Superintendent of the "Old State Prison"—then located in New York city, on the site of what has for years been covered by the buildings of a famous brewing house—and was born on the 4th of August, 1812. He was one of a family of 20 children, of whom he was also the last living representative. Having received the advantages of a common school education, he first turned his attention to mercantile business, meeting therein with varied success, up to 1837, when the growth of the traffic of the Manhattan Gas Light Company opened up to him the opportunity to become attached to its engineering staff. The position of Assistant to Engineer Page was offered to and accepted by him. Observant and attentive, no detail of his new sphere of life was too small to remain uninvestigated by him, and the result was that in 1842 he was named Engineer-in-Chief to the Company. He handled the affairs of the Company in such masterly fashion as to attract the attention of the capitalists who controlled the corporation, and in January, 1854, he was named to the Presidency, succeeding in that position Mr. Henry Young, a name well known and respected in that period of the history of gas lighting. The General acted as President of the Company up to the time of the merger which resulted in the formation of the Consolidated Gas Company, in 1884. He then was elected President of the latter corporation, retaining the office until 1886, at which time the burden of years with their penalty or inheritance of physical waning prompted him to decline a re-election. His confreres, however, refused to relieve him of all active duty, and he reluctantly agreed to serve on the Directorate, and to act as Chairman of the Executive Committee, which places he occupied at the time of his decease.

Turning from his active business life to the record of his connection with the associations formed to further the best interests of the gas fraternity, we find that he was one of those who, in April, 1876, visited Knickerbocker cottage in response

to the now historical call, issued by Messrs. P. E. DeMill, E. T. Watkins and T. C. Montgomery, for a conference as to the advisability of forming an American Association of Gas Engineers. At that conference the General was called to preside, and to his firmness then and subsequently, at times when it almost seemed as if the Association's hold upon existence must be broken, are we, in our opinion, indebted for our Associations as they stand to-day. He was elected to the Presidency of the American Association at the initial conference, but did not preside at the first annual meeting (New York, Oct. 1873), owing to his absence in Europe, his trip being undertaken for the purpose of benefiting his health, then for the first time showing signs of impairment. Though absent he nevertheless held the hearts and minds of his associates, who unanimously re-elected him to the Presidency. These honors were repeatedly conferred on him, until the occasion of the seventh annual meeting (Phila., 1879) when he peremptorily declined a re-election. Anxious to do all honor to their leader the Association thereupon elected him as their first Honorary Member. He was elected to Honorary Membership in the New England Association, at the meeting held in Boston, February, 1877, and was placed on the Honorary roll of the Society of Gas Lighting, in 1884. And thus did his associates delight to show their appreciation of his ability and worth.

Turning aside from his connection with the gas industry, we find that the Engineer and the Executive found time to serve his country in her hour of peril. In the dark days of September, 1861, he organized the 37th New York Volunteers, of which body he was chosen Colonel. The regiment was mustered into service September, 1862, and served in Maryland and Pennsylvania for three months, when they were recalled to New York city. In May, 1863, the regiment was again ordered to the front, to be recalled the following July to New York to assist in quelling the draft riots then convulsing the city. The regiment remained in New York until the expiration of the enlistment term. In recognition of these services Colonel Roome was brevetted a Brigadier-General of Volunteers, the commission being issued by President Andrew Johnson, we think in 1865. Prior to his active services in the war he was a member

of the old Seventh Regiment, State Militia, and in that body attained the rank of Captain of Company D. He was also one of the incorporators of the Veteran Association.

Necessarily, in his time and day he was connected with many benevolent, social and business institutions, and it is needless to add that his part in these was that of prominence. The three most cherished posts thus held by him were perhaps his Presidency of the St. Nicholas Society and his membership in the American Institute and the Society of Mechanics and Tradesmen.

His distinguished connection with the Masonic Order was of the most brilliant kind. In fact no other man connected with the craft in this country has ever gained greater honor or promotion, as a simple enumeration of the posts filled by him will show. He was Past Master of Kane Lodge, No. 450; Past Grand Master of the Grand Lodge, State of New York; member and Past High Priest of Jerusalem Chapter, No. 8; member and Past Commander of the Cœur de Lion Commandery, Knights Templar; Past Grand Commander of Knights Templar, State of New York; Past Grand Master of the Grand Encampment, Knights Templar, United States; and honorary member, thirty-third degree, Scottish Rite, Northern and Southern Masonic Jurisdictions.

Many other important niches in public and private life were adorned by deceased, who in his thoroughness answered every demand and fulfilled every promise.

And so, full of years burdened with rich harvests of sound grain, General Roome has passed over to the majority in ripe fullness of years.

B. F. SHERMAN.

BORN 1841. DIED OCTOBER 31, 1890.

B. F. Sherman, aged 49, who died at his home in New York, October 31, 1890, was born at Athens, N. Y., and went to New York when 18 years of age, and by the time he had attained his majority had accumulated property amounting to more than $150-

ooo by speculation in gunny bags, which he imported from Dundee, Scotland. He had a factory, and sold them by contract to the U. S. Government for use as fortifications when filled with sand. In 1868 he gave up the importation of gunny bags, and did little business other than making some small investments until about 1878, when he became connected with the Yonkers Gas Company, of which he was afterward President. In 1880 he formed a company of [illegible]w York and New Orleans capitalists and established extensive gas works in New Orleans. In 1884 he went from New Orleans to Jersey City and established the Consumers Gas C[illegible]y. Soon after starting the works in Jersey City, Mr. S[illegible] established the Bay State Gas Company in Boston and a[illegible]r organization in Chicago. About three years ago the [illegible]' Bank was established in Boston by a number of [illegible]nan's friends and he was elected a director of it. [illegible] wa[illegible] member of the Manhattan Club, the New York Jockey Club a[illegible] the American Jockey Club. He owned the sailing yacht Sylvie of the Larchmont Club.

NATHANIEL TUFTS.

BORN OCTOBER 28, 1824. DIED NOVEMBER 9, 1890.

Nathaniel Tufts died at his home in Boston on the afternoon of November 9. His death, which was occasioned by a fall from a window on the second (rear) floor of his residence, was peculiarly distressing from the circumstances that compassed it. Mr. Tufts was renewing a sash cord that had parted in a window frame at the rear of the second floor of his house. The sash was down, and Mr. Tufts was standing on the top rung of an ordinary house stepladder, the latter being steadied by his wife. Mrs. Tufts turned to pick something up, when the ladder toppled and Mr. Tufts was thrown through the open window to the pavement below. When willing hands lifted him up a moment or two later, it was found that he was unconscious, and death followed speedily. Mr. Tufts was born in Malden, Mass., on October 28, 1824, and learned the trade of a tinsmith, having been apprenticed in the shop of his father. At the end of his

apprenticeship he went to work on gas meters for a Mr. Darricott, who will be remembered by some as the first Agent for the Boston Gas Light Company. Shortly afterwards the firm name was changed to that of the Boston Meter Company, Mr. Tufts being chosen Superintendent thereof, and acted as such until 1857–8. In 1860 Mr. Tufts started in business himself under the firm name of Tufts, Cheever & Co. In 1862 Mr. Cheever withdrew, and the firm became that of Tufts Brothers, remaining so until 1878, when the present house of Nathaniel Tufts was founded. Personally Mr. Tufts was much liked, and despite his 66 years bore himself with spryness and activity.

WILLIAM MOONEY.

BORN OCTOBER 6, 1838. DIED JANUARY 21, 1891.

William Mooney, who was the son of William Mooney and Mary Thorp, was born in New York city, on October 6th, 1838, and was the great grandson of William Mooney, the latter having been the prime mover in the organization of what is now known as the Society of Tammany Hall, but which was originally called the Tammanial Society, or the Society of Columbia. Left an orphan in his second year, young Mooney was raised by an aunt who lived in Connecticut.

His earlier studies were completed in a boarding school at West Bloomfield, N. J., and from thence he entered the office of one of New York's noted architects—Mr. John B. Snook—and served out a regular apprenticeship. We next find him as an employee in the office of the separate establishment set up by Carl Phiefer, and from there he took service with the Oregon Iron Foundry, of Messrs. Herring & Floyd. Later on he entered the office of Mr. William Farmer—when that engineer resigned from the staff of the Manhattan Company to enter extensively in the general field of gas works designing and construction—and remained with him as his chief man until the retirement of Mr. Farmer from active business. Mr. Mooney succeeded to Mr. Farmer's business.

He was elected a member of the Society of Gas Lighting in May, 1882, and was a frequent contributor of papers at its meetings. He joined the American Association on the occasion of the New York meeting, October, 1887, and since then his was a familiar figure at its annual gatherings.

At the outbreak of the war, the regiment of which he was a member (the 71st New York State, Colonel Vosburgh) was called to the front, and in their 3 months' service took part in the first battle of Bull Run. Again (in 1862), he served his country as a member of the New York State Corps of Engineers, remaining with them to the end of the war. He retired from the service with the brevet of a lieutenant.

He was married in 1868 to Miss Clara Fox, who survives, together with a son and two daughters. The funeral services were celebrated at his late home in Plainfield, N. J., on the afternoon of Sunday, January 25th.

WILLIAM H. DOWN.

BORN MAY 9, 1837. DIED FEBRUARY 15, 1891.

William H. Down was born in the city of New York, on the 9th of May, 1837, and was the son of Samuel Down, whose modest meter shop was known to the gas maker of 1835, even as its successor of to-day is known.

Mr. William H. Down received a thorough education at the institution which is now known under the title of "The College of the City of New York," and all his inclinations were towards the gas industry. We first find him in the 18th street station of the Manhattan Gas Company, at the period when the elder Sabbaton was in charge. In due course of time a favorable opportunity (1865, we think) for promotion presented itself, which was availed of speedily, and this marked his appointment as Secretary and Superintendent of the Greenpoint Gas Light Company, which supplied gas to that section of the present city of Brooklyn, then bounded by Hunter's Point on the north and Williamsburgh on the south. In 1868 the proprietors of the Williamsburgh Company purchased the property and franchises

of the Greenpoint Company, whereupon the latter works were dismantled, although the organization has been maintained. Declining a position in the Williamsburgh Company, Mr. Down entered the service of the American Meter Company, thoroughly perfecting himself in all the details of the business. In April, 1877, he was formally elected Secretary of the Company, which position he held at the time of his decease, as also did he retain the position of Trustee to the Company, to which post he was named in 1881. Of his services in these capacities it is quite unnecessary to comment; for few gas engineers in the country have not had, at one time or another, some sort of useful service from him—a service, too, that never was grudgingly given.

He was a pronounced advocate and staunch adherent of our Associations, and rarely did he miss a meeting of the New England, American or Western Associations, although perhaps his warmest allegiance was to the first-named.

Mr. Down was elected to active membership in the American Association, at the ninth annual meeting, Boston, October, 1881.

He was married in 1864, and all of his immediate family—wife, two sons and three daughters—survive. The harmony of his home life was the hall mark of the true man. This knowledge shall be their comfort when the sting of death is robbed of its sharpness by the merciful touch of memory.

The funeral services were celebrated at the late home of deceased, the services being conducted by the Reverend Dr. Chamberlain, of St. Matthew's. The rites were chanted and sung (the St. Thomas Church quartette assisting) most impressively, amid an assembly of participants, many of whom journeyed hundreds of miles to join in the mournful farewell. Interment was made that afternoon in the quaintly beautiful Sleepy Hollow Cemetery, at Tarrytown, N. Y., where the Down family burial plot is located. At the grave, the full Masonic ritual was beautifully rendered, by a commanding representation from Normal Lodge, F. and A. M., 523, of which body deceased had been a prominent and painstaking member for more than a quarter of a century. Joining the Lodge in 1863, deceased served as Worshipful Master thereof in 1867–8–9, and again in 1886.

EDWARD MEAD RUSSELL.

BORN MAY 31, 1866. DIED MAY 28, 1891.

Edward Mead Russell was born in St. Louis May 31, 1866. His childhood and early youth were spent at his father's home in the suburbs of St. Louis and he was educated in that city at the public schools and Washington University.

When about seventeen years of age he persuaded his father to allow him to go West and obtained a position in Butte City, Montana, remaining there during the winter. In the spring he went on to a cattle ranch near Utica, Montana, where he remained until the following winter when he returned to St. Louis, staying about a year when he returned to Montana.

He then went through the Judith Valley to Wells, Nevada, where he spent some time on a cattle ranch, and returned again to St. Louis when about twenty-two years of age and took a position as traveling salesman for The Parker-Russell Mining and Manufacturing Company, where he remained until his last illness, which confined him to his home for about six weeks; his death occurred May 28, 1891.

He was the same in manhood as when a child, straightforward, fearless and generous, and few men had more friends and less enemies, nor have many given greater promise of a bright future.

His memory will ever remain dear in the hearts of his friends through the country.

SAMUEL PRITCHITT.

BORN 1817. DIED SEPTEMBER 21, 1891.

Samuel Pritchitt, who was born in southern New Jersey, in 1817, at an early age determined to try his fortune in Philadelphia, where he learned the tailoring trade. In 1838 he removed to Nashville, under engagement to take employment with Washington Meredith, as cutter. Prospering fairly well, young Pritchitt (in 1840) opened an establishment in partnership with

Jacob Milliron, buying out the latter's interest in the succeeding year and carried on the business with unvarying success, until 1864, when he retired from the counter and its cares. It must not be inferred that deceased meanwhile neglected to increase his wealth by failing to take advantage of the opportunities afforded by the great growth of the West and South. Careful investment, fostered by patient watchfulness and temperate habits, brought its inevitable result. When the Nashville Gas Company was chartered (1850), deceased and the late Mr. Barrow were among the prime movers in its organization, Mr. Pritchitt, if we mistake not, serving on the first Board of Directors. He always took a lively interest in its welfare, and was chosen its President, in 1881, succeeding Mr. Samuel Watkins in the chief executive position. The history of the Company is a record of success, and it is not asserting too much to say that Mr. Pritchitt's zealous care contributed greatly thereto. He was elected to membership in the American Gas Light Association, at the third semi-annual meeting (Washington, D. C., May 12, 1875), and was a constant attendant at its sessions, until chronic illness made protracted travel dangerous.

Deceased was a valued member of the Nashville Merchants Exchange, President of the Tennessee Manufacturing Company, and a Director or other officer in prominent companies, the naming of which separately would be of no particular moment now. He was closely identified with the leading banking interests of the South and Southwest, and altogether was a man of vast business cares, in strange contrast with the humble beginning of his career. No word was truer than that spoken by Samuel Pritchitt, and amid all his responsibilities, the disfiguring touch of broken faith was never put upon him.

In 1844 Mr. Pritchitt was united in marriage to the eldest daughter of Mr. T. B. Coleman, who was at the time Mayor of Nashville. Their home life was, as his public career, felicitous and worthy, and from it survive two sons, Clark and Samuel, Jr. The funeral services were held at his late home, on Demonbreun street (where he had resided upwards of 40 years), on the afternoon of September 22, and thus was brought to a close the career of a man who, through a long and eventful life, was armed in honor undimmed by the tarnish or taint of hypocrisy.

C. H. NASH.

BORN JULY 1, 1843. DIED NOV. 9, 1888.

Mr. Charles H. Nash was born in Canada in 1843. When still a young man, he came to the States and became a resident of Oswego, N. Y., engaging with his uncle in the lumber trade.

He afterwards left Oswego to engage in the grain business, having his offices in Milwaukee and Chicago.

Mr. Nash began his career in the gas business by organizing the company and building the gas works at Red Wing, Minn.

The process he used in this and a few other works in Minnesota, was the Edgerton oil gas process.

Mr. Nash organized and built gas works in a number of cities in Canada, always leaving them on a sound paying basis.

Mr. Nash left Detroit, Mich., Feb. 13, 1878, came to St. Joseph, Mo., and organized the Mutual Gas Light Company of this city, where he put to work his wonderful energy to make and sell gas as cheap as sold in the European countries.

It was said by a party, whose experience was varied and extensive, that at no works he had ever visited was there as complete apparatus for the manufacture of gas and the making up of the residuals, etc., as at St. Joseph, Mo.

In the year 1879, Mr. Nash suffered a slight touch of paralysis, but he soon recovered and was as good as ever.

Mr. Nash organized the St. Louis Ammonia and Chemical Company, at St. Louis, Mo. and Cincinnati, Ohio.

Mr. Nash was largely instrumental in securing the consolidation, in 1886, of the St. Louis Gas Light Company, St. Louis Gas, Fuel and Power Company, and the Carondelet Gas Light Company. He became general manager of the consolidated companies.

His health was threatened and he began to show signs of that dread disease—paralysis of the brain.

His friends prevailed upon him to resign his position there and seek rest.

He travelled extensively in this country and finally went to Europe, thinking a change might benefit him, but he gradually became worse and died in Naples, Italy, Nov. 9, 1888.

Mr. Nash left a widow (daughter of Tracy) and three little girls.

JOSEPH MARVIN STERLING.

BORN AUGUST 16, 1818. DIED MAY 18, 1891,

Mr. Sterling was a native of New York State. Born in Adams, Jefferson County, Aug. 16, 1818. At the early age of seventeen he set his face toward the west and became a pioneer of southern Michigan with Monroe as his home. He began life for himself in 1832 as a clerk. In 1833 he was sent by Fuller & Sons of Watertown, N. Y., to Clayton on the St. Lawrence, where he opened a branch store. In 1834 he entered the employment of Bancroft & Davis, remaining until fall, when, with no other company than five dollars, he started for the west.

In October, 1835 he arrived at La Plaisance Bay and started in as grocery clerk. In 1838 he bought out a branch store at Petersburgh but sold out the next year and returned to Monroe and soon developed as a good business man in the storage warehouse business, and played a strong hand in the commerce of the place. In 1861 he was made president of the Monroe Gas Light Company, and for several years previous to his death he was at the head of several solid business concerns.

In 1862-3 he was mayor of the city and on several occasions was offered the nomination for governor.

He was a prominent member of the American Order of Odd Fellows and was one of the last surviving charter members of Monroe Lodge, No. 19.

Mr. Sterling was twice married; his first wife was Miss Abby Clarke, to whom he was married Jan. 27, 1843, and who became the mother of four boys and two girls.

His first wife died in 1872 and in 1874 he married Mrs. C. W. Rice, of Buffalo, who survived him. He died on the morning of May 18, 1891, of catarrhal bronchitis and the funeral services were conducted at his home by Rev. S. W. Frisbie of Detroit.

LIST OF MEMBERS,

1892.

The date following each name in this list indicates the date of election of the person to membership in the Association.

HONORARY MEMBERS.

Prof. C. F. CHANDLER, of Columbia College, School of Mines, New York, N. Y. Oct. '75.

WILLIAM KING, Engineer Gas Co., Liverpool, England. Oct. '77.

W. W. GREENOUGH, Boston, Mass. Oct. '78.

HENRY MORTON, Ph. D., President of Stevens Institute of Technology, Hoboken, N. J. Oct. '78.

Prof. E. G. LOVE, Ph. D., Gas Examiner of New York City, New York, N. Y. Oct. '86.

ACTIVE MEMBERS.

Abel, W. G.	Atlanta, Ga.	Oct. '86
Adams, H. C.	Philadelphia, Pa.	Oct. '86
Adams, William C.	Richmond, Va.	Oct. '84
Addicks, J. Edward	Boston, Mass.	Oct. '86
Addicks, F. P.	Boston, Mass.	Oct. '90
Addicks, W. R.	Boston, Mass.	Oct. '90
Africa, J. Simpson	Huntington, Pa.	Oct. '73
Africa, Walter G.	Manchester, N. H.	Oct. '91
Aldrich, J. Frank	Chicago, Ill.	Oct. '90
Allen, Augustus L.	Poughkeepsie, N. Y.	Oct. '75
Amory, Dr. Robert	Boston, Mass.	Oct. '86
Anderson, William	East Boston, Mass.	Oct. '89
Archer, Benjamin F.	Philadelphia, Pa.	Oct. '79
Armington, Col. James H.	East Providence, R. I.	Oct. '81

Atwood, H. A.	Plymouth, Mass	Oct. '83
Bailey, Charles B.	Washington, D. C.	Oct. '89
Barrett, A. H.	Louisville, Ky.	Oct. '78
Bartlett, Edward L.	Baltimore, Md.	Oct. '86
Bates, John W.	Hoboken, N. J.	May '74
Battin, Isaac	Omaha, Neb.	Oct. '73
Bauer, P.	Boonville, Mo.	Oct. '83
Baumgardner, John H.	Lancaster, Pa.	Oct. '79
Baxter, Isaac C.	Detroit, Mich.	Oct. '82
Baxter, Robert	Halifax, N. S.	Oct. '81
Baxter, William H.	Petersburg, Va.	Apr. '73
Beadenkopf, George	Baltimore, Md.	Oct. '91
Beadle, A. B.	St. Albans, Vt.	Oct. '91
Beal, Thaddeus R.	New York, N. Y.	Oct. '91
Beal, William R.	New York, N. Y.	May '74
Bell, H. J.	Camden, N. J.	Oct. '88
Bennett, C. A., Jr.	Freehold, N. Y.	Oct. '91
Benson, Fred. S.	Brooklyn, N. Y.	Oct. '75
Betts, Edward	Wilmington, Del	Oct. '88
Bierce, Frank	Memphis, Tenn.	Oct. '87
Bigelow, Henry N.	Clinton, Mass.	Oct. '88
Bill, George D.	Malden, Mass.	Oct. '78
Blauvelt, Cornelius D.	St. Augustine, Fla.	Oct. '90
Blodgett, Charles W.	Brooklyn, N. Y.	Oct. '84
Boardman, Arthur E.	Macon, Ga.	Oct. '84
Boardman, Henry	Bangor, Me.	Oct. '88
Bodine, Samuel T.	Philadelphia, Pa.	Oct. '86
Booth, Charles E.	Chicago, Ill.	Oct. '83
Borgner, Cyrus	Philadelphia, Pa.	Oct. '80
Bowen, William S.	West Chester, Pa.	Oct. '90
Bradley, Fred. L.	New York, N. Y.	Oct. '89
Bradley, William H.	New York, N. Y.	May '75
Bredel, Frederick	Milwaukee, Wis.	Oct. '85
Brown, E. C.	New York, N. Y.	Oct. '87
Buckman, James	Philadelphia, Pa.	Oct. '90
Burtis, Peter T.	Phœnix, Arizona	Oct. '79
Bush, John S.	New York, N. Y.	Oct. '83
Butterworth, Irvin	Columbus, O.	Oct. '89
Butterworth, William C.	Rockford, Ill.	Oct. '83
Byrne, Thomas E.	Brooklyn, N. Y.	Oct. '82
Cabot, John	New York, N. Y.	Oct '81
Cabot, George D.	Lawrence, Mass.	May '74
Callahan, W. P.	Dayton, O.	Oct. '81
Capelle, George S.	Wilmington, Del.	Oct. '87
Carroll, Francis	New Orleans, La.	Oct. '89
Cartwright, Matt	Rochester, N. Y.	Oct. '74

Cartwright, William	Philadelphia, Pa	Apr. '73
Chadwick, H. J	Lockport, N. Y	Oct. '88
Chambers, John S	Trenton, N. J	Oct. '73
Chollar, Byron E	St. Louis, Mo	Oct. '88
Clarke, George S	Kansas City, Mo	Oct. '88
Clark, Walton	Philadelphia, Pa	Oct. '84
Clary, E. D	Burlington, Ia	Oct. '91
Coffin, John A	Gloucester, Mass	Oct. '86
Coggshall, Henry F	Fitchburg, Mass	May '74
Cole, Thomas W	Altoona, Pa	Oct. '82
Collins, A. P	New Britain, Conn	Oct. '81
Collins, Charles R	Philadelphia, Pa	Oct. '90
Collins, John	Fishkill on the Hudson, N. Y	Oct. '91
Connelly, J. S	New York, N. Y	Oct. '84
Connelly, T. E	New York, N. Y	Oct. '83
Cooper, Arthur F	Exeter, N. H	Oct. '83
Copp, Austin M	Boston, Mass	Oct. '81
Corbett, Charles H	Brooklyn, N. Y	Oct. '82
Cornell, Augustus B	Youngstown, O	Oct. '89
Cornell, Thomas C	Yonkers, N. Y	Oct. '73
Cosgrove, W. L	Atlanta, Ga	Oct. '86
Cowdery, Edward G	Milwaukee, Wis	Oct. '85
Cowing, John H	Buffalo, N. Y	Apr. '73
Coyle, Patrick	Boston, Mass	Oct. '81
Crafts, David W	Northampton, Mass	Oct. '75
Cressler, A. D	Fort Wayne, Ind	Oct. '82
Crisfield, James A. P	Savannah, Ga	Oct. '90
Crockett, Joseph B	San Francisco, Cal	Oct. '83
Croul, Jerome	Detroit, Mich	Oct. '91
Crowell, Fred'k B	New York, N. Y	Oct. '91
Curley, Thomas	Wilmington, Del	Oct. '79
Daly, David R	Jersey City, N. J	Oct. '85
Daniels, John M	Columbia, S. C	Oct. '90
Davis, Frederick J	Waltham, Mass	Oct. '75
Davis, Frederick R	Athol, Mass	Oct. '83
Dell, John	St. Louis, Mo	Oct. '85
Denniston, William H	Pittsburgh, Pa	May '74
Diall, Martin N	Terre Haute, Ind	Oct. '76
Dickey, Charles H	Baltimore, Md	Oct. '83
Dickey, Robert R	Dayton, O	Oct. '81
Dingee, Frank A	Philadelphia, Pa	Oct. '82
Dixon, Robert M	New York, N. Y	Oct. '90
Douglas, David	Minneapolis, Minn	Oct. '88
Douglas, Henry W	Ann Arbor, Mich	Oct. '91
Dyer, Frank H	Salt Lake City, Utah	Oct. '91
Edgerton, H. H	Danbury, Conn	May '74

Edwards, George B.	New York, N. Y.	Oct. '92
Egner, Frederic	St. Louis, Mo.	Oct. '89
Eichbaum, F. H.	San Francisco, Cal.	Oct. '89
Elkins, George W.	Philadelphia, Pa.	Oct. '86
Elkins, William L., Jr.	Philadelphia, Pa.	Oct. '86
Enfield, William	Texarkana, Ark.	Oct. '85
Evans, Charles H.	Chicago, Ill.	Oct. '89
Faben, Charles R., Jr.	Toledo, O.	Oct. '85
Fay, William J.	Denver, Col.	Oct. '84
Findlay, J. H.	Ogdensburg, N. Y.	Oct. '82
Fitz, Robert F.	Elgin, Ill.	Oct. '90
Flemming, Dudley D.	Jersey City, N. J.	Oct. '80
Floyd, Frederick W.	New York, N. Y.	Oct. '82
Floyd, Henry E.	New York, N. Y.	Oct. '82
Floyd, James R.	New York, N. Y.	Apr. '73
Fodell, William P.	Philadelphia, Pa.	Oct. '79
Fogarty, Thomas B.	Long Island City, N. Y.	Oct. '81
Forbes, James	Chattanooga, Tenn.	Oct. '89
Forstall, Alfred E.	Newark, N. J.	Oct. '88
Foster, T. Gardner	Montgomery, Ala.	Oct. '86
Fowler, John	Philadelphia, Pa.	Oct. '79
Fowler, Samuel J.	Springfield, Mass.	Oct. '91
Franklin, S. J	Warren, Pa	Oct. '89
Frost, W. H	Fort Scott, Kan	Oct. '79
Fry, Charles C	Lynn, Mass.	Oct. '83
Fullager, William E.	Port Jervis, N. Y.	Oct. '91
Gandey, A. C.	Lambertville, N. Y	Oct. '91
Gardner, James, Jr	Pittsburgh, Pa	Oct. '83
Gardner, William	Pittsburgh, Pa	May '75
Gartley, William H	Philadelphia, Pa.	Oct. '85
Gates, Frederick W.	Ontario, Can	May '74
Geggie, David H	Quebec, Can	Oct. '81
Gerould, Charles L	Brooklyn, N. Y	Oct. '83
Gerould, Lyman P	Nantucket, Mass	May '75
Gibbs, W. W	Philadelphia, Pa	Oct. '86
Giblin, John A	Ilion, N. Y	Oct. '91
Gifford, N. W	New Bedford, Mass	Oct. '91
Gilbert, Thomas D.	Grand Rapids, Mich	Apr. '73
Gimper, John	Galveston, Tex	Oct. '90
Glasgow, Arthur G	London, Eng.	Oct. '87
Goodwin, William W	Philadelphia, Pa	Apr. '73
Gordon, J. J	Cincinnati, O	Oct. '85
Graeff, George W., Jr	Philadelphia, Pa	Oct. '83
Graves, Henry C	Dayton, O.	Oct. '83
Green, James	St. Louis, Mo	Oct. '85
Greenough, Malcolm S	Cleveland, O	Oct. '78

Gribbel, John	New York, N. Y	Oct. '83
Griffin, John J	Philadelphia, Pa	Oct. '79
Guldlin, Olaf N	Fort Wayne, Ind	Oct. '91
Gwynn, J. W	Bucyrus, O	Oct. '90
Hall, Richard F	Troy, N. Y	Oct. '83
Hallett, Joseph L	New Rochelle, N. Y	Oct. '82
Hambleton, F. H	Baltimore, Md	Oct. '88
Hammett, C. S	Jacksonville, Fla	Oct. '90
Hanford, L. C	Norwalk, Conn	May '74
Harbison, John P	Hartford, Conn	May '74
Harper, George H	Kansas City, Mo	Oct. '89
Harris, J. A	Philadelphia, Pa	Oct. '86
Hauk, Charles D	Chicago, Ill	Oct. '85
Hayes, Charles J	Palatka, Fla	Oct. '90
Hayward, Thomas J	Baltimore, Md	Oct. '84
Helme, William E	Philadelphia, Pa	Oct. '86
Hequembourg, C. E	Bradford, Pa	Oct. '81
Herron, J. T	Buffalo, N. Y	Oct. '90
Hickenlooper, Andrew	Cincinnati, O	May '74
Higby, William R	Bridgeport, Conn	Oct. '88
Hookey, George S	Augusta, Ga	May '74
Hopper, Thomas C	Germantown, Pa	Oct. '76
Hopper, William H	Germantown, Pa	Oct. '82
Hostetter, D. Herbert	Pittsburgh, Pa	Oct. '89
Humes, William S	Altoona, Pa	Oct. '90
Humphreys, Alex. C	Philadelphia, Pa	Oct. '75
Humphreys, C. J. R	Lawrence, Mass	Oct. '81
Humphreys, William	Waterford, N. Y	Oct. '75
Hunt, Thomas	Tonawanda, N. Y	Oct. '91
Hyde, Gustavus A	Cleveland, O	Oct. '82
Isbell, Charles W	New York, N. Y	May '75
Jackson, Walter M	New York, N. Y	Oct. '87
Jones, Edward	South Boston, Mass	Oct. '75
Jones, Edward C	San Francisco, Cal	Oct. '79
Jones, Lewis S	Royersford, Pa	Oct. '83
Judson, Charles E	Chicago, Ill	Oct. '83
Jenkins, E. H	Columbus, Ga	Oct. '91
Jourdan, James H	Brooklyn, N. Y	Oct. '91
Kellogg, L. L	Sioux City, Ia	Oct. '90
Keppelman, John H	Reading, Pa	Oct. '91
Kingsbury, F. D	Corning, N. Y	May '74
Kitson, Arthur	Philadelphia, Pa	Oct. '86
Knight, Elmer B	Hagerstown, Md	Oct. '91
Knowles, John H	Richmond, Va	Oct. '79
Kraft, George W	Philadelphia, Pa	Oct. '79
Kraft, George W., Jr	Philadelphia, Pa	Oct. '86

Kreischer, George F.	New York, N. Y.	Oct. '85
Krumholz, Joseph	Buffalo, N. Y.	Oct. '87
Kuehn, Jacob L.	York, Pa.	Oct. '81
Lamson, Charles D.	Worcester, Mass.	Oct. '81
Lane, James W.	Akron, O.	Oct. '91
Langford, John T.	Boston, Mass.	Oct. '83
Lansden, Thomas G.	Washington, D. C.	Oct. '85
Leach, Henry B.	Taunton, Mass.	Oct. '82
Learned, Everett C.	New Britain, Conn.	Oct. '81
Learned, Waldo A.	Newton, Mass.	Oct. '82
Leavitt, Heyward G.	Grand Island, Neb.	Oct. '84
Lee, Edward C	Philadelphia, Pa	Oct. '86
Light, Joseph	Dayton, O.	Oct. '85
Lillie, Lewis	Philadelphia, Pa.	Oct. '91
Lindsley, Edward	Cleveland, O.	Oct. '76
Littlehales, Thomas	Hamilton, Ont.	May '74
Littleton, Augustus W.	Quincy, Ill.	Oct. '89
Loomis, Burdett	Hartford, Conn	Oct. '84
Lowe, T. S. C.	Pasadena, Cal.	Oct. '86
Lowe, Leon P.	Colorado Springs, Col.	Oct. '85
Lucas, Philip, Jr.	Mt. Vernon, N. Y.	Oct. '87
Ludlam, Edwin	Brooklyn, N. Y.	Oct. '73
Lynn, James T.	Memphis, Tenn.	Oct. '83
MacDonald, Benjamin J	Newburgh, N. Y.	Oct. '90
MacDonald, William	Philadelphia, Pa.	Oct. '89
MacMillan, George	La Crosse, Wis.	Oct. '91
Mactier, Henry	Elizabeth, N. J.	Oct. '90
Mayer, Frederick	Baltimore, Md.	Oct. '84
McCleary, Alex. J.	Philadelphia, Pa.	Oct. '88
McCullough, Edmund H.	Philadelphia, Pa.	Oct. '82
McCutcheon, James	Allegheny, Pa.	Oct. '89
McDonald, William	Albany, N. Y.	Oct. '79
McElroy, John H.	Pittsburgh, Pa.	May '74
McIlhenny, George A.	Washington, D. C.	Apr. '73
McIlhenny, James S.	Washington, D. C.	Oct. '90
McIlhenny, John	Philadelphia, Pa.	May '75
McKeige, Ferdinand	New York, N. Y.	Oct. '90
McMillin, Emerson	New York, N. Y.	May '74
Merrifield, Paul S.	New York, N. Y.	Oct. '79
Merrill, Hiram	Janesville, Wis.	Oct. '73
Merritt, Charles H.	Danbury, Conn.	Oct. '79
Miller, A. S.	Chicago, Ill.	Oct. '89
Miller, C. O. G.	San Francisco, Cal.	Oct. '91
Miller, William B.	Cartersville, Ga.	Oct. '90
Milsted, William N.	New York, N. Y.	Oct. '87
Mitchell, K. M.	St. Joseph, Mo.	Oct. '89

Moore, David	Salem, Mass	Oct. '81
Morgans, William H	Pontiac, Mich	Oct. '87
Morris, Henry G	Philadelphia, Pa	Oct. '79
Moses, George W	Chelsea, Mass	Oct. '80
Murphy, Hugh	Sing Sing, N. Y	Oct. '77
Nash, A. F	Winsor, Ont	Oct. '91
Neal, George B	Boston, Mass	May '74
Nettleton, Charles H	Birmingham, Conn	Oct. '75
Newell, John W	New Brunswick, N. J	Oct. '75
Norris, Rollin	Philadelphia, Pa	Oct. '89
Nute, Joseph E	Fall River, Mass	Oct. '88
O'Brien, William J	Philadelphia, Pa	Oct. '84
Odiorne, Frederic H	Boston, Mass	May '75
Park, William K	Philadelphia, Pa	Oct. '85
Parkhurst, John G	Coldwater, Mich	Oct. '73
Payne, M. J	Kansas City, Mo	Oct. '85
Pearson, W. H	Toronto, Ont	Oct. '75
Pearson, W. H., Jr	Toronto, Ont	Oct. '88
Perkins, James D	New York, N. Y	Oct. '82
Peters, Malcolm	New York, N. Y	Oct. '87
Phelps, E. R	White Plains, N. Y	Oct. '90
Pinkney, Edward A	Utica, N. Y	Oct. '91
Pratt, Edward G	Des Moines, Ia	Oct. '86
Prichard, Charles F	Lynn, Mass	Oct. '83
Printz, Eugene	Zanesville, O	May '74
Procter, William L	Ogdensburg, N. Y	Oct. '91
Quinn, A. K	Newport, R. I	Oct. '87
Ramsdell, George G	Philadelphia, Pa	Oct. '79
Rawn, John C	Roanoke, Va	Oct. '91
Raynor, Charles H	Adrian, Mich	Oct. '73
Read, John	Stratford, Ont	Oct. '88
Reilly, John W	Wilmington, N. C	Oct. '91
Richardson, Frank S	North Adams, Mass	Oct. '81
Ridgely, William	Springfield, Mass	Oct. '85
Ringwood, Thomas	Ilion, N. Y	Oct. '90
Rogers, James F	Jamaica Plain, Mass	Oct. '76
Roots, D. T	Connersville, Ind	Oct. '83
Rowland, Charles L	Brooklyn, N. Y	Oct. '88
Rowland, Thomas F	Brooklyn, N. Y	May '74
Rowland, T. F., Jr	Brooklyn, N. Y	Oct. '81
Rowland, William L	Philadelphia, Pa	Oct. '86
Rusby, John M	Jersey City, N. J	Oct. '88
Russell, Daniel R	St. Louis, Mo	Oct. '87
Russell, J. J	Sheboygan, Wis	Oct. '90
Sabbaton, F. A	Philadelphia, Pa	Oct. '73
Salter, James E	Philadelphia, Pa	Oct. '86

Scrafford, William H.	Bath, N. Y.	Oct. [illegible]
Scriver, J. F.	Montreal, Can	Oct. [illegible]
Searle, Robert M.	Johnstown, N. Y.	Oct. [illegible]
Seaverns, Francis	New York, N. Y.	Oct. [illegible]
Serrill, William J.	Allentown, Pa.	Oct. [illegible]
Shelton, Frederick H.	Philadelphia, Pa.	Oct. [illegible]
Sherman, F. C.	New Haven, Conn.	Oct. [illegible]
Simpkin, William E.	Richmond, Va.	Oct. [illegible]
Sisson, Frank N.	Albany, N. Y.	Oct. [illegible]
Slade, James	Yonkers, N. Y.	Oct. [illegible]
Slaney, H. C.	Brooklyn, N. Y.	Oct. [illegible]
Slater, A. B.	Providence, R. I.	Oct. [illegible]
Slater, A. B., Jr.	Providence, R. I.	Oct. [illegible]
Smallwood, James B.	Baltimore, Md.	Oct. [illegible]
Smedburg, James R.	Hamilton, O.	Oct. [illegible]
Smith, John W.	Philadelphia, Pa.	Oct. [illegible]
Smith, Marcus	Wilkesbarre, Pa.	May [illegible]
Smith, Orlando F.	Washington, D. C.	Oct. [illegible]
Smith, Robert A. C.	New York, N. Y.	Oct. [illegible]
Smith, William H.	Bayonne City, N. J.	Oct. [illegible]
Snow, William H.	Holyoke, Mass.	Oct. [illegible]
Somerville, James	Indianapolis, Ind.	Oct. '75
Spaulding, Charles F.	Waltham, Mass.	Oct. [illegible]
Spaulding, Charles S.	Boston, Mass.	Oct. [illegible]
Spaulding, William H.	Clinton, Mass.	Oct. [illegible]
Sprague, Charles H.	Boston, Mass.	Oct. '82
Stacey, William	Cincinnati, O.	Oct. [illegible]
Stanley, Ira N.	Brooklyn, N. Y.	May '75
Starr, James M.	Richmond, Ind.	Oct. '75
Steck, Henry	Hagerstown, Md.	Oct. '91
Stedman, William A.	St. Louis, Mo.	Oct. '77
Stein, E.	Philadelphia, Pa.	Oct. '82
Stiness, Samuel G.	Pawtucket, R. I.	Oct. '79
Stratton, Rodney J.	Decatur, Ill.	Oct. '86
Taber, Robert B.	Boston, Mass.	Oct. '81
Taylor, George H.	Warren, O.	Oct. '82
Thomas, Joseph R.	New York, N. Y.	Oct. '83
Thomas, Mark B.	Dundas, Ont., Can.	Oct. '88
Thompson, George T.	St. Louis, Mo.	Oct. '91
Thompson, James D.	St. Louis, Mo.	Oct. '85
Tilden, William D.	New York, N. Y.	Oct. '87
Townsend, Sylvanus S.	New York, N. Y.	Oct. '84
Tracy, John	Poughkeepsie, N. Y.	Oct. '91
Turner, Thomas	Charleston, S. C.	May '74
Twinning, Edward H. B.	Chicago, Ill.	Oct. '86
Vail, Robert B.	Rahway, N. J.	Oct. '89

Van Benschoten, Charles C.	New Rochelle, N. J.	Oct. '76
Vanderpool, Eugene	Newark, N. J	Oct. '73
Wagner, Henry D	Philadelphia, Pa	Oct. '86
Wagner, Louis	Philadelphia, Pa	Oct. '87
Waldo, Charles S.	Boston, Mass	Oct. '86
Waldo, John A.	Boston, Mass	Oct. '87
Walker, James H.	Milwaukee, Wis	Oct. '82
Walters, A. H	Johnstown, Pa	Oct. '91
Ward, George M.	New York, N. Y.	Oct. '87
Warmington, Daniel R	Cleveland, O.	Oct. '91
Warmington, George H.	Cleveland, O.	May '74
Watrous, Valentine S.	Little Falls, N. Y	Oct. '86
Watson, Charles	Camden, N. J.	Oct. '81
Watt, Anthony	Connersville, Ind.	Oct. '91
Weber, Adam	New York, N. Y.	Oct. '80
Weber, Oscar B.	New York, N. Y	Oct. '83
Wells, George H.	Nashville, Tenn	Oct. '76
Welsh, William L.	Oswego, N. Y.	Oct. '89
White, Clement A.	New York, N. Y.	May '74
White, Edward D.	Brooklyn, N. Y	Oct. '83
White, Harry H.	Belleville, Ill.	Oct. '91
White, William Henry.	New York, N. Y.	Apr. '73
Whitney, Henry C	Watertown, N. Y.	Oct. '91
Whittier, Charles R.	New York, N. Y.	Oct. '87
Wilcox, H. K	Middleton, N. Y.	Oct. '87
Wilcox, John W	Macon, Ga.	Oct. '90
Willets, Charles A., Jr.	Flushing, N. Y.	Oct. '83
Williams, E. H.	Waterbury, Conn.	Oct. '88
Williams, James	Johnstown, Pa.	Oct. '76
Williams, W. L.	Paterson, N. J.	Oct. '90
Winegar, William J.	Palatka, Fla.	Oct. '90
Wood, Austin C	Syracuse, N. Y.	Apr. '73
Wood, Gideon	New Bedford, Mass.	Oct. '75
Wood, Walter	Philadelphia, Pa	Oct. '81
Wood, William A	Boston, Mass	Oct. '89
Yorke, Eugene H	Brockton, Mass	Oct. '81
Young, John	Allegheny City, Pa.	Oct. '82
Young, Peter	Knoxville, Tenn.	Oct. '85
Young, Robert	Allegheny City, Pa.	Oct. '75
Zeek, C. F.	Pensacola, Fla	Oct. '90
Zollikoffer, Oscar.	New York, N. Y.	Apr. '73

ASSOCIATE MEMBERS.

Adams, Charles F	Buffalo, N. Y	Oct. '91
Barrows, William E	Philadelphia, Pa	Oct. '89
Bradley, Carl D	Chicago, Ill	Oct. '91
Conant, Edward R	New York, N. Y	Oct. '89
Crane, William M	New York, N. Y	Oct. '89
Essick, William S	Royersford, Pa	Oct. '90
Gray, Jerome B	Philadelphia, Pa	Oct. '91
Harris, Andrew	Philadelphia, Pa	Oct. '90
Haywood, Sterling F	New York, N. Y.	Oct. '90
Higgins, C. M	New York, N. Y.	Oct. '91
Hubbard, H. M	Chicago, Ill	Oct. '90
Knight, C. S	Fort Wayne, Ind.	Oct. '90
Logan, William J	Brooklyn, E. D., N. Y	Oct. '89
Manning, James S	New York, N. Y.	Oct. '91
McDonald, Donald	Albany, N. Y	Oct. '91
Norton, Harry A	Boston, Mass	Oct. '88
Oakman, Richard N., Jr	Greenfield, Mass	Oct. '89
Osius, George	Detroit, Mich	Oct. '89
Persons, Fred. R	New York, N. Y.	Oct. '88
Page, Albion L	New York, N. Y	Oct. '91
Page, Harry de B	New York, N. Y.	Oct. '91
Rice, F. B	New York, N. Y.	Oct. '89
Steen, William E	Philadelphia, Pa	Oct. '91
Stratton, Samuel S.	Chicago, Ill	Oct. '89
Sumner, Robert N	Philadelphia, Pa	Oct. '89
Van Wie, Peter G	Cleveland, O	Oct. '88
Walsh, R. D	St. Louis, Mo.	Oct. '89
Wilson, W. I	New York, N. Y.	Oct. '88
Wright, William S	Council Bluffs, Ia	Oct. '88
Yuille, George A	Chicago, Ill	Oct. '91

MEMBERS DECEASED.

George W. Parsons	Rochester, N. Y.	——	—, 1875
Cornelius L. Everett	New York, N. Y.	Oct.	—, 1875
G. T. Sutton	Peekskill, N. Y.	Apr.	—, 1876
Charles Collier	Selma, Ala	May	—, 1876
W. H. Perry	Bangor, Me	May	—, 1877
William B. Clelland	Vicksburg, Miss.	Oct.	15, 1878
Gen. Laz Noble	Vincennes, Ind.	Oct.	18, 1879
George Buist	Halifax, N. S.	Nov.	2, 1879
Oliver G. Steele	Buffalo, N. Y.	Dec.	10, 1879
George W. Edge	Jersey City, N. J	Jan.	1, 1880
Kerr Murray	Ft. Wayne, Ind.	May	6, 1880
John C. Buxton	Springfield, O.	July	20, 1880
George Dwight	Springfield, Mass	Feb.	1, 1881
Elmer W. Clark, Jr	Philadelphia, Pa.	Mar.	5, 1881
Eli Butler	Meriden, Conn.	May	24, 1881
Henry Budd	Philadelphia, Pa.	May	28, 1881
Henry Cartwright	Philadelphia, Pa	June	30, 1881
Edwin Keith	Taunton, Mass.	Apr.	30, 1882
Geo. Warren Dresser (*Honorary*)	New York, N. Y.	May	27, 1883
M. H. Jones	Easton, Pa.	June	1, 1883
W. H. Price	Cleveland, O	June	8, 1883
James D. Merriman	Vera Cruz, Mexico	June	10, 1883
A. W. Richardson	North Adams, Mass.	Sept.	4, 1883
Miles W. Caughey	Erie, Pa.	Sept.	20, 1883
Wilmer G. Cartwright	Hoboken, N. J	Feb.	23, 1884
Philips Peebles	Quebec, Can.	May	15, 1884
I. Herzog	New York, N. Y.	Oct.	23, 1884
Thomas Butterworth	Rockford, Ill.	Apr.	5, 1885
George Cornell	Youngstown, O.	Apr.	22, 1885
Francis Thompson	Charlestown, Mass	Aug.	30, 1885
James D. Brewer	Springfield, Mass	Feb.	7, 1886
Emile J. Durand (*Honorary*)	Paris, France	Feb.	—, 1886
John Anderson	Ironton, O.	June	25, 1886
James H. Walker, Sr.	Tonawanda, N. Y.	Mar.	1, 1887
T. F. White	Houston, Tex	Feb.	28, 1888
John C. Pratt	Jamaica Plain, Mass.	June	7, 1888
William Helme	Atlanta, Ga.	June	12, 1888
Joseph H. Collins	Philadelphia, Pa.	June	26, 1888
John M. Murphy	Baltimore, Md	Aug.	25, 1888

John McDougall	Hornellsville, N. Y.	Nov.	2, 1888
C. H. Nash	St. Louis, Mo	Nov.	9, 1888
John Cartwright	Poughkeepsie, N. Y	Dec.	19, 1888
C. F. Maurice	Sing Sing, N. Y	Dec.	24, 1888
Robert P. Spice (*Honorary*)	London, Eng.	May	11, 1889
Edward J. King	Jacksonville, Ill.	Oct.	28, 1889
Oliver E. Cushing	Lowell, Mass.	Jan.	17, 1890
Theobald Forstall	Chicago. Ill	Jan.	19, 1890
William Parrish	Seneca Falls, N. Y	Jan.	19, 1890
Walter B. Houston	Rahway, N. J	Apr.	3, 1890
James Henri Rollins	Worcester, Mass	June	19, 1890
Gen. Charles Roome (*Honorary*)	New York, N. Y.	June	28, 1890
B. F. Sherman	New York, N. Y.	Oct.	31, 1890
Nathaniel Tuffts	Boston, Mass.	Nov.	9, 1890
William Mooney	New York, N. Y.	Jan.	21, 1891
William H. Down	New York, N. Y.	Feb.	15, 1891
I. Linton	Ravenna, O	Mar.	—. 1891
J. M. Sterling	Monroe, Mich	May	18, 1891
E. M. Russell	St. Louis, Mo.	May	28, 1891
Samuel Prichitt	Nashville, Tenn.	Sept.	21, 1891

GENERAL INDEX

TO THE

PROCEEDINGS

OF

THE AMERICAN GAS LIGHT ASSOCIATION

FROM

COMMENCEMENT TO OCTOBER, 1888.

COMPRISING VOLUMES 1, 2, 3, 4, 5, 6, 7, 8.

PREPARED BY

C. J. RUSSELL HUMPHREYS, Secretary.

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1889.

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